SCIENCE

FRIDAY, OCTOBER 22, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

A CAREER IN MEDICINE AND PRESENT-DAY PREPARATION FOR IT[1]

Mr. President, Members of the Governing Boards and of the Faculty of Leland Stanford Junior University, Students in the University and Guests: It is my privilege to come at the invitation of this university to share in the inauguration of a new department in the university. To-day you are commencing a work which means much for the progress of medicine in this fair land of ours, and to be permitted to share in these exercises is a privilege and an honor which I esteem highly.

I come, too, bearing to you the greetings and good wishes of the faculty of medicine of Harvard University, who welcome you into the fellowship of university medical schools. This band of university medical schools is as yet but a small one. However, in the last decade and a half a slowly increasing number of medical schools have developed as integral parts of universities, constituting genuine university medical schools. Unfortunately this number is even smaller than is at first apparent, for in some instances the union between medical department and university is merely nominal. Small, however, as is this group, it has already exerted a powerful influence on medical education and has been one of the forces at work changing medical instruction and medical schools to keep pace with recent wonderful developments in medical science, and it will play a yet larger part in the medical uplift of the future. To strengthen this group with a

[1] Address at the dedication of the department of medicine in Leland Stanford Junior University, September 8, 1909.

medical school supported by the great resources of this university means much, therefore, as I have already stated, for the progress of medicine in this country, and the medical profession is to be congratulated on your determination to begin a medical department.

It may not be inappropriate at this time, before an academic audience, to discuss the possibilities of a career in medicine and present-day preparation for it, incidentally considering some of the many problems of medical education and indicating the magnitude of the task that lies before this institution in developing a medical department that shall be a credit to the foundation so bountifully provided by Leland Stanford for a great university in this glorious state of the Pacific slope.

If I may be permitted to subdivide this audience, I will address myself especially now to the students present and indicate, as best I can, what a career in medicine has to offer those who undertake the study of medicine. I would have you consider medicine broadly as one of the biologic sciences to be entered into after a collegiate training with some knowledge of others of the group of scientific studies, more especially of chemistry, physics and zoology. After the preliminary training the prospective medical student must devote four years to medical studies, and at the end of these years he should enter a hospital for one or two years of practical work; in all, six years of medical training. At the expiration of these years he may do one of several things: he may begin the practise of medicine; he may become a surgeon, a medical consultant or a specialist; he may choose teaching and investigation, or he may devote his energies to public health work. Here is a wide variety of possibilities for his selection. Which is he to take? Personal desire and adaptability are important factors in the choice. Each offers its own attractions and rewards, measured often by different standards.

To the many in our medical schools the practise of medicine will open its doors and to most of you this work—that of the family physician—is best known. He who enters into the practise of medicine may look forward to a moderate income measured by the standards of modern business and a life that will bring him into a peculiarly intimate, serviceable relation with his fellow men. Probably in no other calling is there such an intermingling of work for wage and work that brings its blessings to others, and in this lies the peculiar charm of the practise of medicine. The physician's advice not only is sought in matters of health and disease, but gradually he grows to be family councillor too, the recipient of family secrets and a sharer in family joys. In many communities the physician is an important figure in all that pertains to the activities of the place, often filling positions of responsibility, a man honored, loved and respected by his fellows. Freely he gives of his time, his mind and his love; but equally great is the reward which he reaps in the gratitude of his patients and in the satisfaction of knowing that within his limitations he has richly given of the talents vouchsafed him. Many are his opportunities for doing good to his fellow men, nobly does he respond to these calls. The charity of the rank and file of the medical profession throughout this broad land of ours is one of the glories of medicine. So to engage in the practise of medicine offers you many opportunities to do good and at the same time this work will furnish you a living income, gained soonest in the smaller places, while in the large cities there are opportunities for obtaining incomes of even large size, but it must be realized that in the large city, though there are great prizes to be won by a few, there are many who will fail in the

competition for them, and the smaller place offers a more certain reward to the medical man of good training, good habits, good health and perseverance.

A smaller percentage of medical graduates may continue their preparation beyond that of the practitioner, with the intention of becoming surgeons, medical consultants or specialists. More and more at the present time is surgical work done by men specially trained and who confine their work to surgery as opposed to the older plan, very generally followed, of each physician doing some operative work. Even with a very great increase in the number of diseased conditions amenable to surgical treatment, one skilled surgeon can do all of the work needed by a population of considerable size and not a very great number of surgeons are needed in a community. Consequently only a comparatively few are likely to attain to success in this branch. For the few who do, the reward is great and the successful surgeon obtains an income large even when compared with the incomes of present-day industrial life, but this success comes only after a period which has involved a number of years' preparation beyond that received by him who enters general practise. A considerable special knowledge of anatomy and pathology is needed by the surgeon and this entails many hours of painstaking work. Then comes the period of assisting some trained surgeon, gradually attaining the manual dexterity and the knowledge that are required for the surgeon. The surgeon's apprenticeship should last six to eight years, years in which his earning capacity has been relatively small and his labors arduous. Remembering this, the surgeon surely deserves a good income when his period of matured activity comes and a small group of men can anticipate this success in surgery.

For the medical consultant a very similar period of preparation is required. This possibility to the young graduate is essentially a recent development in medicine in this country. In the past, the medical consultant has been almost invariably a man of mature years, trained by an extensive general practise from which he has gradually withdrawn as his consultation work has grown. Now there is a field for a differently trained consultant, though there is undoubtedly still a place in consultation for the matured judgment of the general practitioner, where his practical experience is of extreme value. Still the young graduate to-day can deliberately train himself for consultation work. A few years should be spent by him in the laboratory gaining first-hand knowledge of some one of the fundamental sciences of medicine, anatomy, physiology, pathology, bacteriology, chemistry or pharmacology. Then a large part of his time should be devoted to work in the hospital, where he may combine observation of many patients with laboratory investigation, supplementing all, of course, with study of medical literature. Five or six years of such work will give him a deeper knowledge of the facts and methods of medicine than many more years spent in general practise, and this knowledge should be useful to the general practitioner, too busily engaged with routine for maintained study of a subject which like medicine is constantly progressing and developing. Gradually there has come a call for the consultant so trained and I believe in the future an increasing number of consultants will be thus trained and this field of work will be offered as a possible career for the graduate in medicine, yielding him a better income than general practise, though rarely as great as that gained by the successful surgeon.

There are various fields of special medical work open to graduates, such as diseases of the eye, the ear, the nose, etc. In

all of these in the larger places there are men who limit their work to some one of these special branches and for which work they have prepared themselves by several years of special study. In almost all of these special branches of medicine, practise differs from the other fields of medical work already described in that a very large per cent. of the patients come to the office of the doctor and practically all of the work can be done within certain fixed hours, leaving greater freedom to the physician, and this, to many, forms an attraction in these specialties beyond the considerable income that may be derived from their practise.

To the graduate in medicine to whom active practise does not make an appeal, the quiet life of the laboratory and the lecture room is open. Teaching and investigation in medicine, as in other branches of university work, demand a certain number of men. In recent years the demand in this field has been rather in excess of the supply and for a few years this demand is likely to increase gradually, for more and more medical schools are placing the instruction—at least the instruction of the first half of the medical curriculum—in the hands of men who give all of their time to instruction. In addition, various institutions of medical research, independent of medical instruction, have been founded and these require men of medical training to conduct their investigations. Hospitals now employ various laboratory-trained men and furnish occupation for many of this class. So far the demand from hospitals has been largely for men of pathological training, but now the chemist and the physiologist begin to be sought. Clinical teaching and investigation as a career is just beginning to develop in this country, but surely in the near future there will be a considerable demand for men adequately trained for this work. Medical investigation offers a fertile field for the properly qualified man and in it honor and fame will be won in the future as in the past. Teaching in medicine has a certain advantage over academic teaching as a career in that often with the teaching there is combined the opportunity for some remunerative use of the same training as renders the individual successful as a teacher; I refer to demands for his aid in various diagnoses, or the possibility of combining teaching with some salaried position in a hospital or mingling with the teaching a certain varying amount of special practise. In these ways the teacher in medicine is not as absolutely dependent on his salary as a teacher of most other subjects, and in case a teaching berth grows unacceptable, he may fall back on the practise of medicine for a livelihood.

I have not particularly enlarged upon medical investigation as a career, since it is included now so generally in the career of teaching and because pure investigation is not so much planned as a career as the true investigators—very few in number—are spontaneously drawn into it.

Public health work is almost in the beginning of its development in this country, but in a few years it is to be anticipated that there will be a very considerable demand for men trained in hygiene and preventive medicine to serve as health officers and sanitary advisers at good salaries. This is a demand for which our medical schools are just beginning to provide by the establishment of departments, but the next few years will show great advances along these lines and many men will be attracted by this field of work.

I have attempted to point out to you that the prospective medical student is not entering on a career of very limited possibilities, but that after graduation he has considerable choice as to his future work and may choose among several forms of

medical activity that for which he is best adapted.

To the members of the faculty it is evident that to equip students for these various phases of the medical career, a medical school must possess extensive equipment and large resources to which it receives students with adequate preparation to profit by the instruction offered. During the past five years much progress has been made in elevating the standard of medical education by increasing the entrance requirements to our medical schools. There has been much discussion as to the best preparation for the study of medicine. Training in chemistry, physics and zoology with a reading knowledge of French or German are very generally deemed the essentials of a satisfactory preliminary preparation for medicine, because medicine itself is very largely a biologic science, using the methods of these other sciences, and because in the study of anatomy, physiology and medical chemistry much time is otherwise consumed in teaching what the student might readily have learned in college, while the modern languages are needed that the student may utilize more extensively the literature of medicine. Just how much general college training beyond these subjects should be required has been largely debated. No one would deny that the better education the student has before he begins medicine, the more he is apt to profit by his medical studies, yet this may be readily carried to an absurd point since preliminary work consumes time and too much of it would make the period of medical study come too late in life. A college course of three, at most, four years, including work in physics, chemistry, zoology and modern languages and leading to a degree of A.B. or B.S., is at present regarded widely as an ideal preparation for the study of medicine, but this is open to the criticism that it gives us in the medical schools students of too old an average age. Assuming that such a college A.B. or B.S. course is an ideal preparation for medicine, it has already been adopted in several medical schools making the period between entrance to college and the commencement of the practise of medicine a period of from eight to ten years, divided as follows: college three to four years, medical school four years, hospital one to two years.

At present, after such preparation, most men begin medical practise too late in life. To start them earlier in their life work is one of the great problems before us. This can be done best, I believe, by, in some way, lowering the age of entrance to college—perhaps by changing instruction in the preparatory schools. Another method of lowering this age has been sought in the so-called combined course by which the A.B. degree is awarded at the expiration of four years' work, two years' college work, including physics, chemistry and zoology, and two years' medical work and the M.D. degree at the expiration of two more years, a total of six years instead of seven or eight years for the two degrees. But do not let ourselves be deceived by this. Reduced to plain facts this means two years of college work, including physics, chemistry and zoology, as an entrance requirement to the medical school, and such institutions as have the combined course are to be classified in the group of medical schools requiring only two years of college work for entrance unless we attribute some intrinsic educational value to the right acquired by the students of adding A.B. after their names—a thing which I take it no one would claim. Rather does it seem to me that these schools have succeeded in rendering the A.B. degree of less value and significance than formerly and have sacrificed one or two years of college work while seeking to conceal this fact by the award of the two degrees, A.B. and M.D. In the

combined course two years of work are counted for two degrees, another fact which has brought criticism on the plan.

It must be remembered, in discussing entrance requirements, that it is not yet proved whether one or two years of college work beyond the two years demanded by many medical schools as an entrance requirement is of more advantage than a one or two years' earlier start in medical work. It is very generally conceded that a knowledge of physics, chemistry and zoology and the ability to read French and German medical literature, are very helpful to the medical student of to-day who pursues a quite definite curriculum of study, and this knowledge can scarcely be obtained in less than two years of college work. Beyond this we are still experimenting, and gradually by comparing graduates under varying entrance requirements we may satisfactorily solve the problem. It is very important that this be done, and for this reason I have discussed the combined course and pointed out that it should be classified where it belongs,—*i. e.,* as two years of college work for entrance to the medical school.

The problem is further rendered complex by students transferring from one school to another. A university, in fact, may discriminate against its own students if it requires a degree for entrance, does not give a combined course and accepts students with credit for advanced standing who have had part of a combined course. Under these circumstances a graduate of its own collegiate department must spend at least one, possibly two, more years between college entrance and graduation in medicine than the student transferred from the institution giving a combined course. This actually happens in certain institutions. So in the solution of our problem students transferred from one school to another must be carefully classified to prevent incorrect deductions from our statistics.

Making these allowances, we have now very fair conditions for comparing students with various preparations, since schools with good medical equipment are making these different requirements for entrance. The evident advantages so far gained by demanding for entrance to the medical school, a college degree with certain specified studies are: a more mature, uniformly trained student easier to teach; a decreased number of students receiving more personal attention, and an increased number of hours available for medical studies gained by the relegation to college of preliminary courses in physics, chemistry, zoology and botany, formerly included in some form in the medical curriculum. Opposed to these are certain disadvantages: the relatively old age at which the medical man actually begins his life work; the barring of medicine to men unable to secure the preliminary education among whom will undoubtedly be men of great potential ability; the possible lowering of the standard of country practitioners, as the college-bred man tends to have an aversion to country life and will leave country practise to graduates of the poorer medical schools which usually keep behind the latter in their demands for preliminary education. To-day the advantages appear to outweigh the disadvantages, though it does not seem advisable were it possible to increase at once entrance requirements in all schools to a college degree. To have done so in certain schools has greatly benefited medical education, but the future may show that the pendulum has swung too far or that it has not swung far enough. We must regard the matter as still in the experimental stage and every institution must seek to contribute towards its solution.

Having determined on a standard for

admission to the medical department here at Stanford, what preparation should the faculty seek to give its students for a career in medicine? It is evident that if, as I have pointed out, the career of medicine offers several possibilities for life-work, the medical school must furnish a certain elasticity of preparation. However, you must recognize first of all that by far the larger number of your students will become general practitioners and the world at large will judge the success of your medical school by the type of general practitioner you send out. To the casual observer a medical school is merely a place for training men for the practise of medicine—it is to them a technical school, not a university department. So you must seek to train your men for this part of the career of medicine as well as it is possible. On them will rest a great responsibility—the responsibility of giving to their fellows the best that modern medicine has to offer in preventing disease, in mitigating its pains and in curing its attacks. With a broad knowledge of medicine as a biologic science, with an intimate knowledge of the normal and abnormal mechanism of mind and body, with a rational grasp of all forms of therapeusis and a thorough training in the diagnostic methods of medicine, you must prepare your students for this responsibility. There will, of course, be laboratories and clinics with adequate equipment, representing an investment of many thousands of dollars. Men to man these you will secure, choosing the best in the land, for after all, men more than buildings are the particular pride of universities.

The organization of the departments giving instruction in the first two years of the medical curriculum is easier to-day than of those dealing with the later years, the clinical instruction. In our medical schools there is more uniformity of instruction in anatomy, physiology, chemistry, pathology and bacteriology than in the other branches of the medical course, and I believe good instruction is more generally given in these. One reason for this is that the necessary money is the only limitation to the possession of satisfactory laboratories and to obtaining competent men for these subjects. Sufficient material for instruction is usually quite easily obtained. On the other hand, to the satisfactory development of clinical instruction conditions in American medicine have furnished many obstacles—obstacles which I trust this university is to take an active part in removing. For satisfactory efficient clinical teaching hospitals are absolutely essential with many patients with which students can come into close contact. The separate development in America of hospitals and medical schools has retarded clinical teaching. In this country hospitals are usually municipal or privately-endowed institutions under their own governing boards. With rare exceptions do medical schools exercise any influence in determining staff appointments in these hospitals. In them seniority promotion is often the rule and this in itself withdraws a very strong stimulus for the best work and acts to retard the development of members of the hospital staff. Under these conditions the medical school has but little choice in its selection of professors and instructors in clinical subjects. The man controls the clinical material which the medical school must have and so he becomes professor whatever may be his qualifications for teaching. Very generally in our hospitals members of the staff are on duty but three or four months of the year. This necessitates multiplicity of teachers and prevents continuity of instruction and investigation. These are factors on the side of American hospital organization which have acted to retard clinical teaching and clinical investigation and which should be changed in

the future. A medical school must control appointments in the hospitals where its clinical teaching is done and the terms of service must be continuous throughout the year if the highest development is to be attained. Clinical professors, like other university professors, must be chosen because they are the best teachers and investigators available and this can never be the case so long as only local men are possible of selection.

Medical schools themselves have been responsible in part for the present state of clinical teaching on account of the very meager salaries, or worse still, no salaries, paid its clinical teachers. This has resulted frequently in teaching receiving just as much attention as under these conditions it deserved, *i. e.*, secondary consideration. Medical schools have expected the clinical teacher to be remunerated by the advertising the position gave him and when the advertising was profitable they have complained because private practise has interfered with school work. What else, pray, could be expected? Let us suppose that a university had attempted to develop its chemical department, for example, by limiting its choice of instructors to its locality, paid them slight or no salaries, asked them to make a livelihood doing private chemical work, such as assays, etc., and had them work in buildings and with apparatus owned and controlled by another corporation. How absurd the proposition! How could a university chemical department develop under these conditions? Yet these are conditions not essentially different from those under which many, many medical schools have attempted to develop clinical departments.

I would impress on the governing boards that a medical department is very expensive. Numerous laboratories are needed, and much apparatus. Professors and instructors in the laboratories must be paid university salaries and often the maximal salaries, since there is a growing demand for the better instructors, and an institution can not afford to lose too many of its trained men. Clinical professors must be paid salaries, too, in proportion to the time they give to teaching work. Of clinical teachers there should be two classes, those who devote a large part of their time to medical school work and those who devote a small part. In the first group should come at least the heads of the more important departments, such as medicine and surgery. Some advocate having professors of medicine and surgery who engage in no private practise but confine their work to the medical school and the hospital. It is an advantage, however, to my mind, for them to do a limited amount of private work because much of the best material for study comes through these channels and, on the other hand, the public has a right to some of the services of these more highly trained men. These men will probably have to be paid more than university salaries for both hospital and medical school work, since they would be men who in private work would earn far larger incomes. In addition to these men devoting the major part of their time to academic work, the services of the men in private practise are needed. They are in a position to teach to students particularly well the art of medicine, if I may use the word without being misunderstood. From their particular experience they have something of value to impart to students and they should be made use of and paid in ratio to the time devoted to teaching. Then the medical school of to-day requires a very large teaching force, since so much of the teaching can be done satisfactorily only in small groups of students. This again increases the cost of medical instruction.

In medical schools the older fixed curriculum is giving place to a modified elect-

ive system in order that medical instruction may have that elasticity demanded by the different possible lines of work to be followed by the graduate. Election within the medical curriculum is at present somewhat limited by the requirements of the state licensing boards and as almost all graduates will practise medicine in some form, each medical school must offer a curriculum meeting the requirements of these boards. However, such can be met and still the student be allowed considerable freedom of election. At Harvard there is now complete freedom of election in one year of the four years of medical study and this has proved a satisfactory arrangement. This question of freedom of election in medical studies must be carefully considered in the future. It must be recognized that our present more fixed curriculum has been somewhat more an accidental development than a studied, planned growth. New subjects of a developing medical science have in the past been crowded into the curriculum. Now that is full and new subjects can be added only as the result of readjustment of the curriculum or be left to an elective period. This fact will necessitate in the future change in our medical instruction and will be a probable cause of extension of election in medical studies. If a very free elective system develops, entrance requirements again will need readjustment and these are problems for much thought by medical pedagogians. The proper position of the so-called specialties in the medical curriculum will be another problem for future consideration. A glance at the course of study in different medical schools will show much variation in the number of hours required in this or that specialty, indicating the action of local influences more than thought as to the real needs of the students. An elective system may aid in adjusting the specialties but still a necessary minimal must be determined for the student destined for general practise. Up to the present time the gradual growth and development of special fields of medical work has exerted a disintegrative influence on medical instruction resulting in a higher development of the resulting parts, but now there is need for integration and balanced adjustment of the parts to form a more perfected whole.

In a medical school equipped for proper training of practitioners there will, of course, be laboratories and men capable of conducting advanced work in various branches of medicine, to prepare students as surgeons, consultants, specialists, teachers, etc. This part of the medical work constitutes university work in the usually accepted idea in contradistinction to college and technical-school work. Advanced students and instructors will conduct investigations and publish, for the use of the world, their results. Without this no medical school can be regarded as a university medical school. What attitude should the university at large assume toward university medical work? There has been a marked tendency on the part of academic circles to disparage the work of medical departments and a lack of disposition on the part of university professors to accept work in medical subjects as university work. Happily this attitude is disappearing, though in rare instances is the medical work accorded its true place in the university organization. There is no essential difference between the methods followed by the pathologist in his investigations and those followed by the zoologist in certain of his fields of work; the medical chemist uses the technical procedures of the organic chemist; the bacteriologist is an investigator in a special field of botany. That, in the medical departments, man and his diseases is the ultimate subject of study is no reason for regarding these studies as less

cultural than other university subjects. Is there any real reason why an advanced student in zoology should be awarded a higher degree, such as that of doctor of philosophy, for special sustained work in that subject, while this degree is withheld from the advanced student in pathology or anatomy or any other medical subject? You all know the opposition offered by the departments of literature, language, philosophy, etc., in the past to the recognition of the sciences as university subjects and parts of the curricula of candidates for the bachelor of arts degree. Gradually, however, this opposition gave way and the sciences were received by the academic councils on the same footing as the older humanities. Some such process is now going on in medical subjects. I believe the day will soon come when higher degrees will be awarded for medical studies, just as for other university subjects. Perhaps some of the faculty present may resist this move. I trust not, but if they do, I feel sure that eventually they will be on the losing side. Harvard, I am glad to say, has already recognized this claim of medicine and there is, in the organization of the faculty of arts and sciences of Harvard University, a division of medical sciences similar in organization to the division of ancient languages, or other divisions of that faculty, granting higher degrees—master of arts, master of science, doctor of science and doctor of philosophy—as in other divisions of the university faculty of arts and sciences. This division of medical sciences is composed at present of members of the departments of chemistry, physics and zoology, of the faculty of arts and sciences and of members of the departments of anatomy, comparative anatomy, physiology, comparative physiology, pathology, comparative pathology, bacteriology and biological chemistry, of the faculty of medicine and there are candidates for higher degrees working in several departments of the Harvard Medical School.

The next logical development in medicine as a university subject will be the acceptance of some of the clinical branches as proper training for higher degrees. I realize that this idea will be repugnant to many in academic circles who regard medicine and surgery as purely technical professions. A comparatively few years back and such was the case. Examination of a modern department of medicine as an example, however, serves to show that there have been great changes in the past twenty years and that now there is much similarity in the methods and ideals of a department of medicine to the methods and ideals of the various university departments. The department of medicine of a present-day university medical school has a laboratory equipped with apparatus for chemical, pathological and physiological investigation and men capable of utilizing this equipment in investigation. By the experimental method diseases are produced and abnormal functions studied. The hospital, with its patients, is another great laboratory into which natural disease comes for investigation and the attitude of the department of medicine toward the hospital is not essentially different from that toward the laboratory. The student and investigator in both seek to add to the knowledge of disease facts that may eventually be applied to the alleviation and prevention of the sufferings of humanity. In the hospital are individuals seeking cure from disease and the physician brings to their aid all that medical science can offer. In the diagnosis of their disease the methods and resources of the laboratory are utilized. The treatment applied often has been evolved as the result of animal experimentation. The result of the treatment on the particular individual is part of a great experiment built up of innu-

merable observations of just such individual cases. To each individual the physician applies the method which, based on previous experience, would seem to offer him the greatest aid. In receiving the best that medicine has to offer, the patient is contributing a part to further advancement of medical science. It is universally conceded that a university hospital with such a relation to laboratory and medical instruction affords its patients the most accurate diagnosis and the best treatment possible.

Now, if in such a department of medicine investigations are conducted by the methods of the biologic sciences with the view of adding something to the sum total of human knowledge, is there any essential difference between its methods and ideals and those of any university department?

Many studies of the heart beat in animals have been awarded a Ph.D. degree in university departments of physiology. If in a department of medicine the heart beat of man is studied, should less credit be given for equally good work? Surely, the turtle's heart beat is of no greater import than that of man. But you say that in the turtle you can control the conditions of the experiment—not in man. True, but in man, natural disease often performs the experiment for you. Take the condition of heart-block in which disease has severed the continuity of conduction impulses between the auricles and ventricles of the human heart, and produced disturbances in the cardiac system which may be investigated during life by methods of the physiological laboratory applied to man. Investigations of these conditions controlled by animal experiments in the laboratory have already thrown much light on the physiology of the heart and seem adequate for higher degrees, if higher degrees are already awarded for quite similar studies in university departments. This is merely an example of many others that might be cited. Thought on these will, I am sure, convince you that to accept certain forms of work in modern clinical departments for higher degrees is not irrational. Work of this type should afford the best preparatory training for teachers in clinical subjects, as is universally acknowledged to be the case for other university teachers. A medical school thus organized as part of a university will form both the best type of professional technical school and a real university medical school. Nor will the advantage of such an organization be solely on the side of the medical school. The separation, in this country, of the medical school and the university has taken from the university the activities of men who, in other countries have added much to the glory of the universities. The medical school will find inspiration in the ideals and spirit of university work, and the essential unity of medical science and other sciences will be realized in this country when universities and medical schools are closely united.

The development in the west of great universities has brought to the east the stimulation of competition and has resulted in increased development of the eastern universities. The development of western medical schools will, in the same way, stimulate progress in eastern medical schools. We, of the east, have welcomed the organization here in the west of university medical schools, realizing that you will take students that otherwise we might get, but knowing that, from your work, we shall learn, that as you grow we shall grow and that American medicine in this way will attain to that development which the resources of this country amply justify. So we all wish you God-speed in the undertaking which you are inaugurating to-day and gladly welcome you into the brotherhood of medical schools. We shall watch

your development with the greatest interest, expecting to learn much from the way you meet the educational problems of a developing medical science.

To the authorities of Stanford University I can only say, cherish well this new offspring of your university, nourish it carefully, expend on it richly of your resources, that an institution may grow here, a pride to the university, to the state and to the country. In its proper development you will richly reap from your investment, even though the investment be very great. May the medical department of Leland Stanford Junior University have a long and useful career, may its faculty and students contribute richly to the widening of the horizon of medicine, and may its future graduates carry comfort and healing to thousands of suffering humanity.

HENRY A. CHRISTIAN
HARVARD MEDICAL SCHOOL

SUGGESTIONS FOR THE CONSTRUCTION OF CHEMICAL LABORATORIES[1]

General Construction.—For a chemical laboratory there is probably nothing better than the so-called slow burning or mill construction. While lath and plaster may be more handsome from an artistic point of view, yet it suffers from the serious disadvantage that the ceiling becomes disintegrated from the acid fumes, with the inevitable result that it drops into the quantitative determinations, to their ruin, or hangs in festoons or fragments that are anything but artistic.

Walls.—The walls should, if possible, be faced with white glazed brick; if this be prohibitive on account of cost, at least where they are exposed to view. In place of this, possibly pressed yellow brick, white "silica" brick, or ordinary red brick painted white may be employed. The paint employed should contain no "white lead," but may be sublimed lead ($PbSO_4$), barytes or zinc white, or preferably a mixture of these in about equal proportions or lithopone. Some of the so-called cold water paints have been used with fairly good success. They may turn black in damp weather, but usually return to their white color when dry.

Floors.—If care be taken to keep the joints tight between the walls and floors there is probably nothing better for a laboratory floor than asphalt. The writer knows of some laid twenty-five years ago that have required no outlay for repairs and are apparently good for another quarter century. Laboratory desks and heavy apparatus should be supported on a broad framework to prevent them from sinking too deeply into it. The asphalt, as wood floors, should be laid upon a heavy grooved and tongued wooden floor with paper between. These floors can be supported upon double wooden beams or upon iron beams kept well painted with a metal varnish coating. Rift hard pine, birch or maple, when carefully selected and laid, makes a good floor, particularly if kept well oiled. This has the disadvantage of making it slippery. It is of course not as tight as an asphalt floor.

Ceilings.—Too much attention can not be paid to their construction, as the writer knows of three large new laboratory buildings in which a more or less constant precipitation of sawdust, paint and plaster is taking place upon the floor below, because of an oversight in this particular. This, in one case, is due to the application of a cold-water paint, which is scaling off from the ceiling when the floor above is walked upon. In the other two cases sufficient care was not taken to sweep clean the first layer of floor boards before laying the second. All

[1] This paper was practically in its present form in November, 1907, nearly a year before the articles lately published in SCIENCE.

this can be obviated by putting in a ceiling of matched boards *after all floors have been laid.* It should be finished with shellac or coach varnish. Something of a pitchy or resinous nature should be used (and yet contain no common rosin, as that is far from durable), rather than a paint which can peel or flake off. This should be borne in mind in all overhead construction. As has been said, plaster of any kind is inadmissible in a ceiling on account of its disintegration by acid fumes. Cement is no better, as in one laboratory of which the writer knows, a cement ceiling began to flake off within about six weeks after occupation.

Fire Walls and Protection.—The building should be subdivided into areas of suitable size by fire walls extending from top to bottom; all apertures in these walls should be guarded by automatic fire doors. The library, if there be a departmental one, should be housed in a fireproof room and also be protected from being flooded by leaks on the floor above. The more dangerous laboratories—the organic, the oil testing and those below or adjacent to the library should be rendered safer by the installation of sprinklers. Somewhere in the building there should be a fireproof room for the distillation of inflammable substances. In addition to fireproof stairways a sufficient quantity of outside iron fire escapes should be provided and the exits thereto carefully indicated and kept unfastened. Inch rubber fire hose with nozzle should be provided in each laboratory. Rubber is better than linen or any other collapsible type of hose, in that it does not kink and thus can be taken through doorways when there are self-closing doors without checking the stream of water. A number of small hose are better than large hose in the hallway, in that they are more accessible, and if used, do not deliver such a torrent of water as to occasion a greater loss from water than from the fire itself. Pails of sand with scoops are very efficient and should be found in every laboratory. No money, however, should be wasted on the purchase of "dry powder fire extinguishers," of which Dr. Freeman says "we recommend that they be thrown into the rubbish heap."[2] If these are wanted they can be easily made by filling tin tubes with two or three pounds of "anchor dust" or waste bicarbonate of soda. In the organic and oil testing laboratories or any other where the fire risk is unusual, in addition to these safeguards above mentioned and automatic sprinklers, some type of portable chemical fire extinguisher should be included. This, as is well known, employs carbonic acid generated by the action of sulphuric acid upon baking soda to throw a stream of carbonated water about, which is especially effective in tar and chemical fires.

A large douche bath with quick opening valve has been found very convenient in extinguishing fire on a student's clothing. This is merely a rose, or better a flat hollow disk a foot in diameter with concentric slits in it, through which the water issues in a shower; it is set seven feet from the floor.

Heating and Ventilation.—The so-called "plenum system" for the general heating and ventilating of a laboratory building may be said to work fairly well, but it must be supplemented by steam radiators and by independent fans, one or more for each laboratory, drawing upon the hoods. These can be placed in the laboratory or, better, on the roof. The hoods in addition to having the usual outlets at the top should be provided with an outlet at the bottom, as most of the gases and vapors of which the

[2] "On the Safeguarding of Life in Theaters," p. 87.

chemist wishes to be rid are heavier than air. Besides the fan draft in the hood the flue should be so arranged that a good sized Bunsen burner can be kept burning in it for use when the fans are not running.

Hoods.—These can in general be disposed of about the laboratory walls and be constructed of wood, pine, white wood, cypress or "asbestos wood" or "asbestolith" with wooden or asbestolith sashes. Where the material is exposed to steam, hot air, or unusually corrosive agents, they perhaps can be made of glass, wired glass, admitting of large panes set in lead-covered sashes.

Iron settings for the glass, unless kept well painted, are not to be recommended. Possibly these sashes may be omitted, and the hoods built after the manner of show cases of plate-glass show windows, by drilling and holding the glass plates in position by angle irons kept well painted with a pitchy "paint." The backs and tops of the hoods can be lined with the same material, where wood is inadmissible, and it is desired to secure freedom from scaling from the brick walls. The use of hoods extending over each desk, as in Edinburgh, is of doubtful expediency and renders the laboratory dark and fills the ceiling up with their exit pipes. The use of small low hoods at each desk would seem to render the piping system complicated and expensive. Except in very special cases the necessity of an individual hood close at hand is not very great. The bottoms can be made of concrete or wire lath, tile or soapstone, and the hoods should not be more than 18 inches deep. The ducts from the hoods can be made square or rectangular, of the wood or the asbestos compositions mentioned. If of wood they can be grooved and tongued, glued and nailed together and varnished. If made of iron they should be painted with an asphalt or pitchy paint, as "chrysolite" (Solvay Process Co.). Aluminum paint is not found to protect iron as well as has been claimed for it.

Laboratory Desks and Lockers.—So far as the writer's experience goes, the responsibility for their selection lies usually with the architect, and it is common experience that architecture and chemistry do not "mix"; that is, good architectural students are oftentimes deficient in chemistry.

Quartered-oak desks and alberene stone tops seem almost as much out of place amid the fumes and acids of a chemical laboratory as dress suits for the students. Even a casual visitor can not help having a pang of regret to see a fine quartered oak panel ruined by the attack of sulphuric acid or caustic soda. Speaking from wide observation and the experience of others, the writer is convinced there is no better (and in the long run cheaper) material for the tops of ordinary laboratory desks than wood. Tiling is always uneven, lead is untidy and expands but does not contract when heated, glass cracks, and all are cold to the touch. For the tops of laboratory desks or tables the following woods have been found to give good satisfaction: Northern pine, whitewood, cedar and California redwood. These may be finished with equal parts of linseed oil and turpentine, or, better, filled with aniline black made in the pores of the wood, according to the following procedure: Apply to the wood solution one, and after it has dried in, solution two: Solution I., 100 grams aniline hydrochloride, 40 grams salammoniac, dissolved in 650 c.c. of water. Solution II., 100 grams copper sulphate, 50 grams potassium chlorate, dissolved in 650 c.c. of water. Oak, ash, or cypress can not be recommended, the former two because they shrink too much and the last because it is very splintery. If the tops are made of two-inch stuff they can be planed down

from time to time and even turned over, when one surface is too far gone for planing. Such tops have been known to last with constant usage in an organic and analytical laboratory for nearly thirty years. These plank tops should be made of lumber as wide as possible and be carefully jointed and well glued together. When properly done it is rare that the glued joint starts. From some laboratories which the writer has seen it would not seem advisable to build the tops of narrow seven eighths inch floor boards even when fastened to a second seven eighths inch top; the joints open and the boards warp and curl making a very undesirable, uneven surface.

Desk Hardware.—For locking the desks, iron hasps and screw eyes and heavy padlocks have given excellent satisfaction even with freshmen, for twenty-five years' constant use. These locks[3] are bronze throughout, with brass or bronze springs and six secure levers, master-keyed, with changes permitting at least four hundred in a series: they are circular, except for the shackle, and about two and one fourth inches in diameter and cost about a dollar each. They should be oiled annually with a light non-gumming petroleum spindle oil. Padlocks have the advantage over mortise locks, keyed or keyless, in that if they fail to open the screw eye can be cut with a blacksmith's bolt cutter, the padlock removed and the cut screw eye replaced by another. The damage to the desk is nothing compared with that incident to forcing a drawer or hammering the lock loose or off by a punch on the round key-hole standard. They have the additional advantage that they, being laid on their side, in the drawer when not in use, are not exposed to the corrosive action of chemicals spilt upon them. These run down the mortise lock around the bolt and levers and stick them fast. Their sole disadvantage, as against combination locks, lies in the loss of the key. The losing of keys can be largely prevented by requiring the use of key chains attached to the bunch of keys and also by informing the student that they are charged one dollar each if lost. They have the advantage that they are much more easily opened, while if the combination be forgotten the instructor has to search it up in the records. Unless the combination on each lock be changed annually, an elder student, a sophomore, for example, would have access to the desk which he used as a freshman, which is now occupied by another student, a serious disadvantage. The changing of several hundred combinations annually is no trifling task. Hard-wood knobs are to be preferred to metal knobs or handles. The Fogg adjustable ball catch with the ball on the *standing* part of the desk has given excellent service. Iron hinges are apparently as good as brass and are cheaper.

Piping and Drainage.—All pipes and drains should be arranged so that every foot can be easily rendered accessible for inspection and repairs. This can be brought about by the "top system" of pipes and drains on the desks and these connected with the main system under platforms running along one end of the desks. Or the piping can be arranged upon the back of one line of desks and the other line, which is movable, backed up to it. Iron piping should be used as far as possible, the outside being painted with a pitch or asphalt paint. Lead lined pipe instead of lead would seem to be satisfactory for suction. For peaty service waters, black pipe fills up rapidly with zooglea, crenothrix and iron rust. This can be avoided to a large extent by the use of galvanized iron or lead-lined pipe. For drainage the lead-lined or even plain

[3] Made by the Miller Lock Co., Philadelphia, Pa.

wooden troughs kept well painted with thin coats of asphalt have given good satisfaction. They are much to be preferred to lead pipes, which continually give trouble from clogging. In concrete construction the writer has these troughs replaced by trough-like depressions made in the floors and lined with asphalt. Care should be had to make these of sufficient capacity and fall; they are covered with slate or cast-iron slabs. The vertical drains should be constructed of hard baked Akron tile or better yet, chemical pottery, and the joints made with cement or possibly with the same material as the asphalt floors. These vertical drains can either be in the elevator well or in a square space in the wall, it being closed with doors so that they too, are readily accessible. Individual traps and vents are not needed in the various laboratories, but the whole system should be effectively protected by traps in the basement. For sinks the ordinary round stoneware wash bowl may be used. This is made with an overflow, and instead of the usual brass fitting at the bottom a porcelain tube two or three inches long projects from it, carrying eyelets at the top on either side of the bowl. The tube fits down into a piece of lead pipe two feet long which empties into the trough on the back of one line of desks. This lead pipe is supported at the top by the eyelets just mentioned. These pipes can then be easily replaced by the janitor, the services of the plumber not being needed. Each laboratory should be provided with valves so that the steam, water and gas can be shut off from it without disturbing another room. The gas valve should be placed near the exit so that it can be closed nightly and diminish the danger from fire.

Augustus H. Gill

Massachusetts Institute of Technology,
March, 1909

THE PRINCIPLES OF THE CALCULUS AS APPLIED IN THE TECHNICAL COURSES OFFERED AT THE UNIVERSITY OF ILLINOIS

Considerable discussion has been aroused in mathematical and engineering circles by the publication in Science of the papers presented at the symposium on mathematics for engineering students held in Chicago at the time of the joint meeting of the American Mathematical Society and the American Association for the Advancement of Science. The committee appointed soon after this meeting is now formulating a course in mathematics intended primarily for engineering students, and their outline will undoubtedly be accepted as a syllabus of the mathematics required by students in technical courses throughout the country. In this connection it may be suggested that some notions as to the contents of such a course might be obtained from an investigation of the various technical courses offered at some university maintaining a school of technology of recognized standing. It would be of interest to know what principles, say of the calculus, are actually used, and how often, in a single complete course or group of technical courses. Data on the relative frequency with which these principles are used might suggest the amount of emphasis to be accorded each in a course of mathematics for engineers. On the other hand, such data should also suggest to the teacher of mathematics those principles which, though not emphasized in the application, should constitute an important part of any well-rounded course in the calculus. The gaps to be thus filled become apparent on investigating what principles of the calculus are emphasized throughout the technical courses actually offered.

In this investigation I have considered the technical courses as offered in the college of engineering of the University of

Illinois and have made two assumptions which no doubt hold elsewhere.

First. Text-book work predominates throughout, and hence the texts used furnish a rational basis from which to judge both the kinds of principles used and their frequency of application.

Second. The principles, as applied in these texts, are used as often in the lectures and problems given for solution as in the texts themselves.

The list of authors of the texts studied includes the names of men connected with at least a dozen technical schools of recognized merit besides those of men at Illinois. The emphasis placed on the principles of the calculus will, necessarily, vary with the instructors in charge of the different courses; yet, as giving an average, the above assumptions seem reasonably accurate.

Any investigation of this nature will undoubtedly show that algebra and trigonometry are used much oftener than the calculus; in fact, in the comparison of numbers it would seem that the calculus plays but a minor rôle. In enumerating the principles of the calculus four complete courses were investigated. These are architectural, civil, mechanical and electrical engineering. Similar courses offered, such as municipal and sanitary, railway, civil and others, furnish results in every way analogous to those above mentioned. The architectural engineering course is included

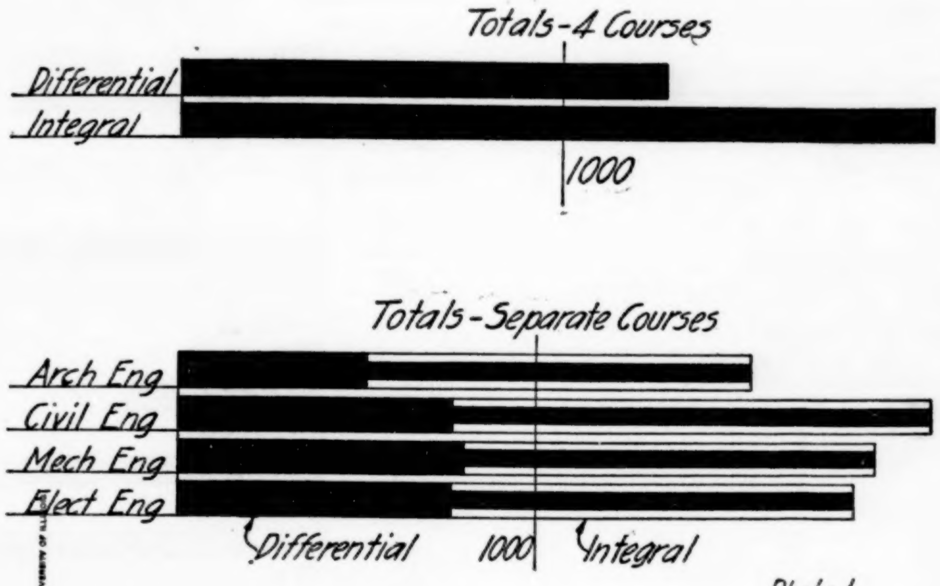


Plate 1

because in it, as offered at Illinois, are included those courses which form the backbone of all the subjects which make use of the calculus. These courses vary all the way from that in architecture, where mechanics is taught without a course in the calculus, to those in which the mathematics used furnishes the most serious difficulties met. If then a summary is made of the principles used in the four courses mentioned we have the results, as shown in Plate 1. This shows the minimum number of times a student in any of the courses listed might reasonably expect to encounter the various principles of the differential and integral calculus. Plate 1 gives us quantitative results; a qualitative analysis is given in Plates 2 and 3.

Concerning the notions of the differential calculus used it can be said that the differentiations, both algebraic and trigonomet-

ric, are almost always of the simpler sorts; in fact, as compared with algebra employed, they are very easy. Difficult differentiations occur rarely, while the trigonometric are usually limited to combinations involving sines and cosines.

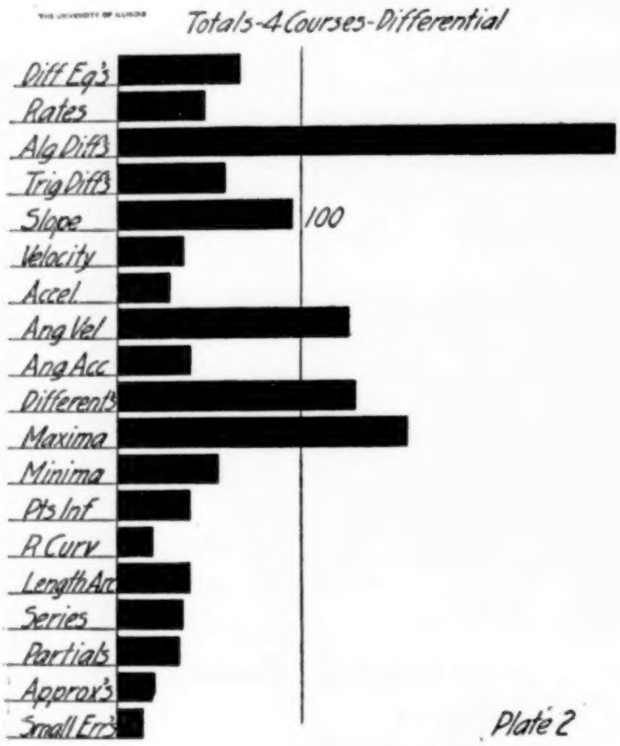


Plate 2

The use of differentials almost invariably brings in the notion of infinitesimals, and it is in this connection that the instructor of mathematics in preparing the future engineer can do an excellent work in giving clear notions of the differential, which need in no wise antagonize the use of the infinitesimal.

The engineering texts are certainly addicted to a rather loose use of the notion of the derivative curves corresponding to the elastic curve for concentrated loadings. A common tangent to these elastic curves at points of discontinuity of the derivative curves is frequently mentioned, and quite erroneously.

Increments and differentials are often used quite synonymously, limits are rarely mentioned, though understood to exist throughout. The duty of the mathematician is clear here, but rigor should in every case add to clearness of concept.

The subject of maxima and minima is handled without the aid of the second derivative, the nature of the problem and result being sufficient in almost every case

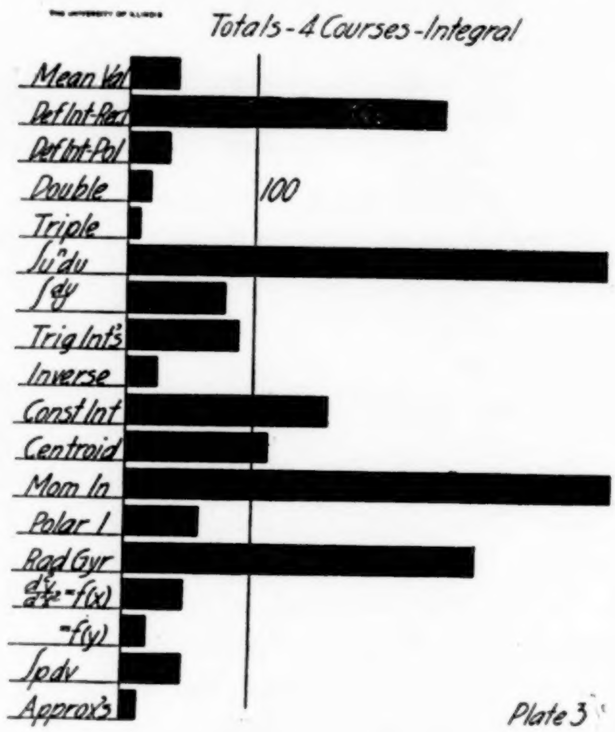


Plate 3

for the determination of the complete solution. Maxima and minima are often found when no first derivative is equated to zero; in fact, many cases arise where the notions exist quite sub rosa, because rigid conditions for maxima and minima can, of necessity, exist but approximately. Relative maxima and minima are emphasized and lead to a term such as maximum maximorum. It might be well for the instructor of mathematics to emphasize this feature more in his teaching. Maxima and minima are often solved from the standpoint of algebra and trigonometry.

The series found are usually simple in construction and the question of their convergence is mentioned in but a single text.

The integrals used in almost all cases arise as a consequence of the summation

process, as would naturally be expected, and the integral is most frequently that of a power of the variable or function. Double and triple integrals occur but rarely, not but what they could be used

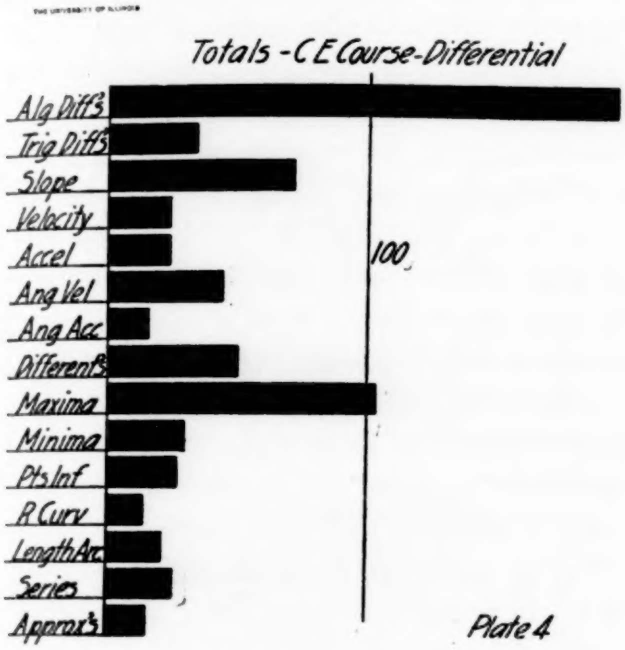


Plate 4

much oftener—but they aren't. The integrals found are simple and the trigonometric are usually limited to combinations of sines and cosines.

The symbol of summation occurs frequently, while the limit of the same is rarely mentioned.

The constant of integration quite often composes the greater part of the indefinite integral, in both size and importance.

Calculus notions, such as moment of inertia, centroid and radius of gyration, occur so frequently that there are portions of certain courses which use very little else in the way of calculus. The question may be raised as to whether these should be classified as principles of the calculus or of mechanics, and the answer to this is that the various texts in the technical subjects assume that the student has learned them in the study of the calculus as a prerequisite.

The principle of mean value as used to find mean pressures, forces, etc., is restricted to the M.E. and E.E. courses.

The limits of the definite integrals used are generally quite apparent from the nature of the problem. The mathematician may well learn a lesson here in the art of making his problems both practical and concrete.

A comparison of Plates 4 and 5 will show that the matter of partial differentiation is one in which the mechanical engineer alone seems to be interested. In this connection it might also be mentioned that the principle of exact or inexact differentials, otherwise known as the integrability condition, plays quite an important and definite part in certain discussions, and that it is deserving of more attention than it receives at the hands of the authors of texts in the calculus.

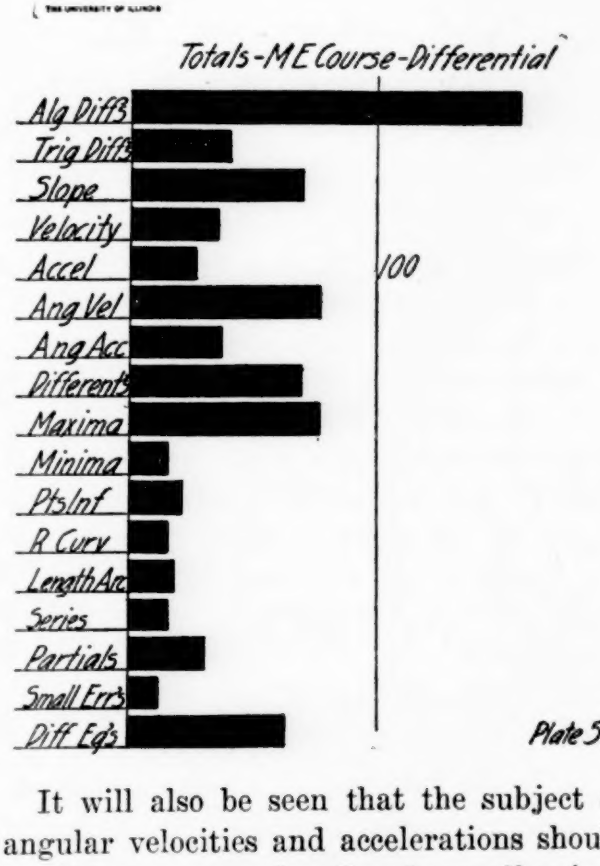


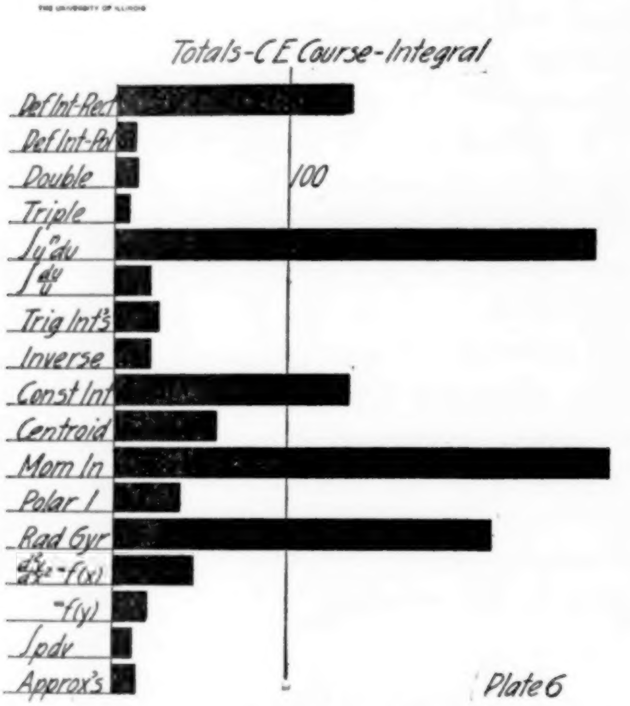
Plate 5

It will also be seen that the subject of angular velocities and accelerations should receive more attention than is usually given to it.

The study of differential equations, espe-

cially from the standpoint of their interpretation, is a feature of the M.E. and E.E. courses.

Plates 6 and 7 seem to indicate that the M.E. course requires a more general use

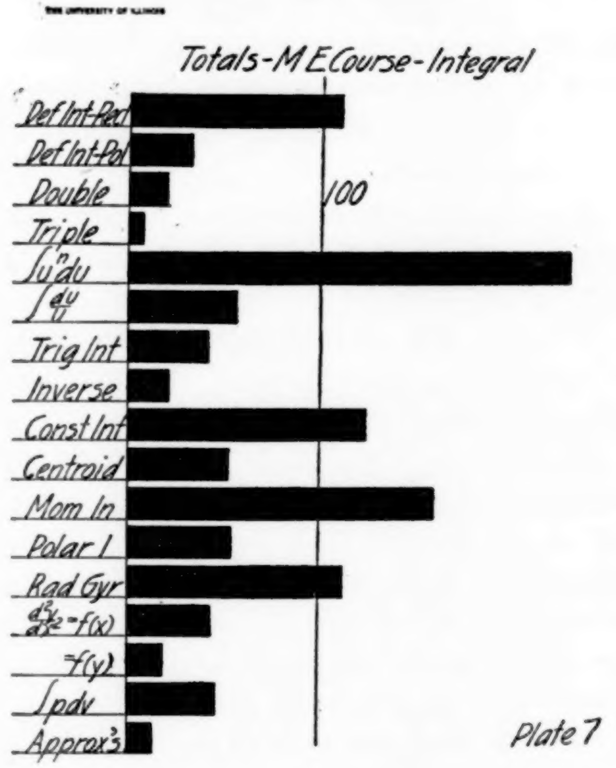


of the principles of the integral calculus than the C.E. course.

If we look for such articles as the evaluation of indeterminate forms, complicated integrals to be broken up into partial fractions before integrating, long reduction formulas, fancy substitutions, forms of remainders, order of contact, envelopes, subtangents and the like, we won't find them. Many curves are used and should be studied more for their properties than they are, one reason why they are not being the fact that the equations of so many of the curves which arise can at best be found only empirically.

It might seem that the matter of approximations is neglected in the enumeration because of the fact that so many approximations must necessarily occur in engineering practise; but in the list of those enumerated none were included which did not have a strong flavor of the calculus, which fact excluded many often listed under the head of approximate integrations, such as the use of Simpson's rule and the like.

Can we learn any general lessons from the results of the investigation? Easily. It is apparent to even the casual observer that the subject which stands out most prominently is that of the formulation of the definite integral with its limits. Here it is a question of whether or not the student can think mathematically, whether he is alive to the situation and grasps the problem before him, and whether he can express existing conditions in mathematical language. He should know the fundamental principle of the integral calculus well, and should have a check on his work wherever possible. A planimeter should find its place in the same class-room with the slide rule, and both should be used as early as possible for checking up results.



It is not sufficient to have theory only, for engineering by its very nature calls for results. The notions of the calculus are not used blindly, each has its specific ap-

plication, and the student must at all times be alive to the situation before him. It is the province of the mathematician to point out the limitations placed upon the use of the principles, not in the spirit of criticism, but of mutual help; for approximations must come into the work of the engineer, and a lot of the calculus used must be of the rough and ready sort. If the treatment can not be rigorous at all times it is the province of the mathematician to point out just how far the engineer may go and how near ideal conditions he is working—not to suggest that the whole structure is built on an insecure foundation. The engineer and mathematician can help one another, on the side of the engineer in presenting live problems in which the mathematician should be interested, and on the side of the mathematician in helping put the whole subject on a safe foundation; both working with the spirit of mutual assistance toward the doing of things worth while, not only to the engineer, but also to the mathematician.

Ernest W. Ponzer

SCIENTIFIC NOTES AND NEWS

The Palmer Physical Laboratory of Princeton University will be formally opened on the evening of October 22, when Dr. Elihu Thomson will give the principal address. The American Physical Society will meet at Princeton on the following day, and in the evening there will be a reception at the Nassau Club.

Dr. T. W. Richards, professor of chemistry at Harvard University, has been given the honorary degree of doctor of philosophy by the Czech University of Prague.

The British Institute of Marine Engineers has awarded the Denny gold medal to Mr. W. P. Durtnall, for a paper on the generation and electrical transmission of power.

It is proposed to celebrate the fortieth year of university teaching of Professor Enrico H. Giglioni, of Florence, by presenting him with an album containing the autograph signatures of zoologists and anthropologists throughout the world. Those who wish to join in this testimonial are requested to send their autograph to Dr. Enrico Balducci, Via Romana 19, Florence.

Dr. Josef von Hepperger, professor of astronomy at Vienna, has been appointed director of the University Observatory.

The trustees of the Lincoln State School and Colony, at Lincoln, Ill., have provided for the establishment of a department of clinical psychology in the state institution for the feeble-minded. Dr. Edmund B. Huey, who has spent the past year in clinical study in Paris, on leave from the University of Pittsburgh, has been appointed to take charge of the new department, and has begun his work at Lincoln.

Professor R. S. Tarr, of the department of geology of Cornell University, has sailed for Europe, where he will spend a year on sabbatical leave.

News has been received from Dr. T. G. Longstaff to the effect that he has arrived at Leh, in Ladak, after having connected the Tarim river with the Saichar glacier.

Mr. Shackleton has left England on a continental tour, and is to tell the story of his Antarctic expedition in the principal cities of Europe. On October 9 he was to be the guest of the Royal Geographical Society at Copenhagen. He will proceed to Stockholm and Christiania, and afterwards will visit Brussels, Antwerp, Berlin, Rome, Vienna and Paris. In March he leaves England for America on an extended tour.

The program for the meeting of the American Mathematical Society on Saturday, October 30, will include a paper by Professor Carl Runge, Kaiser Wilhelm professor at Columbia University, on "A hydrodynamic problem treated graphically."

The faculty of fine arts of Columbia University announces a series of four lectures to be given on Monday afternoons at 4:10 o'clock in Havemeyer Hall, by Charles E. Pellew,

E.M., adjunct professor of chemistry, upon the subject "Practical Dyeing," as follows:

October 18—"Dyeing of Cotton with Modern Dye-stuffs."

October 25—"Tied and Dyed Work."

November 8—"Dyeing and Adulteration of Natural Silk."

November 15—"Manufacture and Dyeing of Artificial and Imitation Silk."

The first Hunterian lecture of the Hunterian Society was delivered on October 13 at the London Institute by Dr. Sidney Martin, who discussed certain infective processes in the intestine and their results and treatment.

A course of twelve free lectures under the Swiney trust will be given at the Victoria and Albert Museum, beginning November 6, by Dr. T. J. Jehu, on "The History of Northwest Europe during Tertiary Times."

M. J. A. Fraissinet, secretary of the Paris Observatory, died on August 29, in his sixty-third year.

Dr. George Edward Post, for many years head of the Medical College at Beirut, the author of text-books in Arabic on biological subjects, has died at the age of seventy-one years.

The second International Congress for the Repression of Adulteration in Food, Chemical Products, etc., to be held in Paris on October 17-24, will include sections as follows: (1) wines, alcohols, syrups, liquors, beer, cider; (2) farinaceous foods, baking, pastries, meat and other pastes, spiced confectionery; (3) cocoa, chocolate, confectionery, honey, sugar and sugar candy; (4) vinegar, mustard, pepper, spices, tea, coffee, chicory; (5) butter, milk, cheese, eggs; (6) lard and edible fats, margarine, provisions preserved in oil, bacon, sausages and pork products, salted provisions and canned and bottled goods; (7) drugs, chemical products, essential oils, etc.; (8) mineral water (medicinal) aerated waters, ice.

It is stated in *Nature* that an Italian National League against malaria has been formed, and the first meeting has been held at Milan. The inaugural address was by Professor Baccelli, and the following communications have been promised: the present state of knowledge in regard to malaria, by Professor Bordoni-Uffreduzzi; prophylaxis against malaria, by Professor Castellino; the pathology of malaria, by Professor Golgi; some questions relating to the pathology and treatment of malaria, by Professor Grassi; little known abortive forms of malaria, by Professor Queirolo.

It is stated in the *Nation* that the Russian Ministry of Marine is equipping three expeditions to be sent out in the year 1910 to explore the coasts of the Arctic Ocean. One steamship will go from Vladivostok to find its way along the coast of northeast Siberia from Bering Strait to the mouth of the Lena, and is to spend from three to four years in this task. A second expedition will visit the Taimyr Peninsula for hydrographical and topographical investigations. The third expedition, which, like the last, starts from St. Petersburg early in 1910, will follow the land route to the Taimyr Peninsula, and will study particularly the courses of the rivers and the geology, climate and meteorology of the country, establishing local meteorological stations.

At the New York November meeting of the American Society of Mechanical Engineers, to be held on the ninth in the Engineering Societies Building, 29 West 39th Street, at 8:15 o'clock, there will be two papers presented. One by Professor Gaetano Lanza and Lawrence S. Smith, of the Massachusetts Institute of Technology, on "Reinforced Concrete Beams," and the other by Professor Walter Rautenstrauch, of Columbia University, on "Stresses in Curved Machine Members." The paper on reinforced concrete beams is the same as that given at the Boston meeting of the society on October 20. It compares the results of tests upon full-sized beams made at the Massachusetts Institute of Technology and the University of Illinois with three different theories of beams of this type. The paper on stresses in curved machine members outlines the method of procedure for the design of principal sections of hooks, punch and shear frames and other curved machine parts. Experimental results are submitted in support of the theory presented.

The following lectures will be given in the department of chemistry, of the College of the City of New York:

November 5—"The Latent Photographic Image," by Professor W. D. Bancroft, professor of physical chemistry, Cornell University.

November 19—"The Warfare of the Future," by Mr. Hudson Maxim.

December 3—"Explosions in Coal Mines," by Dr. J. A. Holmes, chief of the Testing Bureau, U. S. Geological Survey.

March 11—"Coal Tar Colors," by Professor I. W. Fay, professor of chemistry, Brooklyn Polytechnic Institute.

March 18—"Enzyme Action," by Dr. P. A. Levene, chief of the division of chemistry, Rockefeller Research Laboratory.

April 8—"Chemical Equilibrium," by Professor Arthur E. Hill, professor of chemistry, New York University.

April 15—"Chemistry of Digestion," by Professor W. J. Gies, professor of physiological chemistry, College of Physicians and Surgeons.

April 22—"Conservation of the Waters of the State," by Dr. Ernst Lederle, former chairman of the Board of Health, and sanitary engineer.

During the year 1909–10 the series of lectures given by Cornell University in cooperation with the New York State Department of Health upon the subject of "Sanitary Science and Public Health" will be continued. Following is a list of the lectures for the first term:

October 5—President Schurman: Introductory lecture, outlining the field and subject matter of the course.

October 7—Dr. G. W. Goler, health officer, Rochester: The history of therapeutics, showing the barbarism of ancient methods of hygiene and medical knowledge.

October 12, 14—Dr. E. H. Porter, state commissioner of health: Public health administration in general; state control of certain specified diseases and insanitary conditions.

October 19, 21, 26, 28—Professor J. W. Jenks: Social problems in their relation to public health.

November 2, 4, 9, 11—Professor W. F. Willcox: Prolongation of human life; the classification of causes of death; marriage and divorce; the birth rate.

November 16, 18—Professor F. A. Fetter: Philanthropy and public health.

November 23—R. A. Pearson, State Commissioner of Agriculture: The relation of rural communities to the public health.

November 30, December 2—A. H. Seymour, secretary of the state department of health: The development of the public health law and the state control of health; provisions of the public health law as applied to specific regulation.

December 7—Professor S. H. Gage: The application of the laws of heredity to public health.

December 9—Professor E. B. Titchener: The influence of the mind upon private and public health.

December 14—F. L. Hoffman, statistician of the Prudential Insurance Company: Problems of life and health in industry.

December 16—Dr. W. L. Russell: Insanity and public health.

December 21—Dr. H. J. Webber: Betterment of agricultural conditions.

January 6—Dr. B. R. Wakeman: Modern surgery with reference to the prolongation of human life.

January 11, 13—Director V. A. Moore: The nature of disease; micro-organisms and their relation to disease.

The *Scottish Geographical Journal* gives some details in regard to Captain Scott's proposed Antarctic expedition. The main object would be to attempt to reach the pole, and with this object two bases would be established, one at McMurdo Sound, and one if possible in King Edward VII. Land. The attack on the pole would be made from one or other of these bases according to circumstances. Three separate means of traction would be employed—ponies, dogs and motor-sledges. The experience gained by Mr. Shackleton's party would be utilized as far as possible in determining the special circumstances in which each would be employed. Thus, ponies proved suitable for traction over the surface of the barrier, but not for glacial work, for which dogs would be used. Although Mr. Shackleton's motor-car did not prove a success on the soft snow of the barrier, much is hoped of a new type of motor-sledge with which experiments have been recently made. Food would therefore be transported to the foot of the glacier either by ponies or by motor-sledges, while the final dash to the pole, once the plateau had been reached, would be made with the help of dogs.

The scientific objects of the expedition may be briefly stated as follows: 1. Geographical.—To explore King Edward's Land, to throw further light on the nature and extent of the great Barrier ice formation, and to continue the survey of the high mountainous region of Victoria Land. 2. Geological.—To examine the entirely unknown region of King Edward's Land and continue the survey of the rocks of Victoria Land. 3. Meteorological.—To obtain synchronous observations at two fixed stations as well as the weather records of sledge journeys. 4. Magnetic.—To duplicate the records of the elements made by the *Discovery* expedition with magnetographs. The comparison should throw important light on secular changes. 5. Miscellaneous.—In addition, attention will be paid to the study of marine biology at both stations and in the ship, and the examination of physical phenomena will be continued. The plan which has been outlined to secure the main object of the expedition, together with subsidiary plans for the complete exploration of the region of King Edward VII. Land, will necessitate the establishment of a strong party of men at the winter stations and a more ample equipment than has hitherto been taken. It follows that the ship in which the expedition embarks must be suitable in size as well as strong enough to enter the heavy pack ice likely to be met with in the region of King Edward VII. Land. These considerations prevent the full realization of the project under a total estimated expenditure of £40,000. The steamship *Terra Nova*, which served as a relief ship in the *Discovery* expedition, has been purchased for the expedition.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Andrew Carnegie has subscribed $100,000 to McGill University as a part of the general fund of $2,000,000 which friends of the university are trying to raise.

The University of California has purchased 250 acres of land adjoining the campus. This land comprises the inner portion of Strawberry Cañon, running to the crest of a ridge of the Berkeley Hills.

The John Morley Chemical Laboratories of Manchester University were opened on October 4 by Sir Henry Roscoe, who was for many years the professor of chemistry of the university. Lord Morley, the chancellor of the university, in whose honor the laboratories are named, made the principal address.

At Princeton University Dr. E. P. Adams, assistant professor of physics, and Dr. L. P. Eisenhart, instructor in mathematics, have been promoted to professorships.

Dr. Ralph Edward Sheldon, associate in anatomy in the University of Chicago, has been appointed as assistant professor of anatomy, in charge of histology, embryology and neurology, in the University of Pittsburgh Medical School.

At Cornell University H. E. Howe and H. O. Taylor have been appointed instructors in physics.

At Wellesley College, Miss Louise S. McDowell has been appointed instructor in physics.

At Birmingham University the chair of zoology, rendered vacant by the death of Professor T. W. Bridge, F.R.S., has been filled by the election of Dr. Frederick William Gamble, F.R.S., and Professor Peter Thompson, of King's College, London, has been appointed professor of anatomy in the place of Professor Arthur Robinson.

Professor George A. Gibson, of the Glasgow and West of Scotland Technical College, has been elected to the chair of mathematics at the University of Glasgow.

DISCUSSION AND CORRESPONDENCE

A NEED OF INTERNATIONAL CONGRESSES

In Science for September 17 appeared the very interesting account of the proceedings of the Seventh International Congress of Applied Chemistry, held in London in May, 1909. This account is impressive in many ways, and especially in one, of which, possibly, the author, Professor Baskerville, was not conscious. The report throws into strong relief the great

need of such international gatherings—an international language, in which the proceedings may be held, in order that all the participants may understand fully and immediately what is being done.

It is stated in the report that distinguished men of chemical science were present from more than twenty nations, yet the business of the congress was transacted in four languages only, English, French, German and Italian. After the name of each speaker is given the language used—confined, of course, to the four named. It is a fair question to ask if those present from Russia, Spain, Sweden, China, Japan and other lands, understood all or any of the speeches; or if, indeed, even some of those speaking in one of the languages named, understood the remarks of their colleagues using some of the others. How many of the delegates were debarred from participating in the debates because they did not know, or were unskilled in the use of the official languages, and how many of those present were compelled to await the publication of the proceedings before being able to digest them and were compelled, even then, to rely upon the work of a translator? How much valuable time was lost in interpreting the speeches or in repetition of the same remarks in four different tongues?

The Societa Fotografica Italiana presented to the Section of Photochemistry an album of photogravures, showing the effects of the great Messina earthquake, and it was necessary to print the text in four languages, and doubtless this course was also followed in publishing the *Proceedings* of the congress. Does this not seem to entail much labor and expense which science should be able to find means to avoid?

Dr. Wiley, in urging upon the congress the acceptance of the invitation of the United States government to hold the next meeting in America, voiced his appreciation of the language difficulty when enlarging upon the number of foreign-born citizens of the United States and in assuring the delegates that they could count upon being welcomed in their own tongue; though, apparently, he did not venture to promise them that they would be able to understand the proceedings of the congress itself.

These and other items appearing in Professor Baskerville's report show plainly how the diversity of language still stands like a menacing angel with drawn sword at the portal of all international gatherings, threatening with misunderstanding and difficulty all who seek to enter. How long will civilized humanity, and particularly scientific humanity, upon which depends the progress of the race, submit to such humiliating conditions?

The question presses harder to-day than ever before, as modern progress makes international communication more frequent and necessary. Surely science, which has leveled so many obstacles before advancing mankind, must soon give its serious attention to this one, which looms so large, and more especially so, because the solution of the difficulty is so obvious. This solution is the world-wide adoption of an *international* language—a second language which all will learn in addition to their natural tongue, and by means of which they can communicate with all civilized men. What language to select for the purpose is, however, not so obvious and here the difficulties arise. It is not necessary to enter here into a discussion of these; Dr. Kellerman, in an illuminating article in the *Popular Science Monthly* for September, has taken up the whole matter most thoroughly and it would appear that the conclusion reached in that article, viz., the official adoption of the artificial international auxiliary language Esperanto, a living tongue already largely used for the purposes in view, is the logical one. This language seems to be making good its claim of easy acquisition, combined with power of euphonious and clear expression, and being widely disseminated already, seems to await only general official recognition by governments and prominent international associations to prove the actual solution of the troublesome question.

That this is believed by many scientific bodies is shown by the fact that they have already taken the step indicated and made Esperanto their official language. The Pan-

American Scientific Congress at Santiago, Chile, in January, 1909, with official delegates from twenty American governments present, not only took such action, but, in addition, adopted on January 4 the following resolution:

Considering, that a neutral auxiliary international language is necessary, and observing that the idiom Esperanto fulfils the requirements, that it is already sufficiently widespread throughout the world, and that official propaganda alone is lacking:

1. That the First Pan-American Scientific Congress decide to express to the American governments the pleasure with which it would view the call for a congress to which would come official representatives of all civilized countries, with the purpose of solving the problem of the adoption of a neutral international auxiliary idiom; and

2. It agrees to urge upon the government of the United States of North America that, under its grand auspices this desire of the Scientific Congress may be effected.

The next Congress of Applied Chemistry meets in America in 1912, the same year in which the next Pan-American Scientific Congress will gather in the same country. May we not hope that before that time the expressed desire of the latter will be realized, and that, led by the United States, as suggested, the governments of the nations will place in the possession of every man the instrument by which he can make himself understood by every other man?

At Washington, in the summer of 1910, will meet still another international body, the Sixth Annual Esperanto Congress, and if the experience of recent preceding years is duplicated, there will gather in attendance delegates from thirty or more nations, speaking as many languages; but, in great contrast to the congress, the report of which inspired these remarks, the proceedings will be in only one language—Esperanto. No time will be wasted in translation or repetition and *all* the members will understand *everything* that is done, *at the time*, and will be able to discuss freely all the matters presented. Every international gathering and association can do the same, if it will, instead of continuing to struggle with the archaic system now in vogue.

Surely all our scientific brethren will soon recognize this fact and a new step upward in human progress will have been achieved.

J. D. HAILMAN

PITTSBURGH,
September 22, 1909

THEORY AND HYPOTHESIS IN GEOLOGY

THE importance of hypothesis and of theory in geological research, as indeed in every other branch of learning, can not be over-estimated. Concrete facts are valuable, and their observation and accumulation are indispensable, but, in pure science, they are of worth chiefly in so far as they are available in explaining the cause of the phenomena for which they stand. The purpose of such science is to ascertain why and under what circumstances present effects were produced. Every hypothesis and every theory is therefore an attempt to expound the relations between cause, condition and effect.

Granting that observation, as far as pursued, has been correct, there are still many reasons for disagreement in theories. Scantiness and multiplicity of data may lead, respectively, to error of interpretation and to variety of inference. In both events, the personal equation is at a maximum. Again, lack of experience—that is, want of a thorough acquaintance with all the facts, not only in the specific case which serves as a foundation for the theory, but also in all similar occurrences—may result in diversity of opinion. Very common, too, has been the tendency to exaggerate the importance of some one particular factor or cause. Consider, for example, the numerous efforts to account for a glacial epoch. This fallacy is due partly to the personal equation, partly to a failure to discern all the premises, and partly to an innate desire for simplicity, a craving which induces the theorist to assign but one cause to a given phenomenon.

The misconception of the need for unity of cause may be an outgrowth from the doctrine of uniformity. But uniformity is not synonymous with simplicity, any more than complexity is synonymous with chaos. Nature is orderly; its realms are everywhere subject to

unchanging law; yet nature is intricate, profoundly intricate, and its processes interact beyond man's faculty of perception.

How the idea of complexity in nature is important may best be seen in its application to cause, condition and effect, the three essential topics of every theory. According to this conception, one effect may be the result of several causes. For instance, as Professor Crosby pointed out some years ago,[1] eskers may be partly of subglacial and partly of superglacial origin, and a single esker may be both in different portions of its course. The hydrocarbons, in their various occurrences, do not always satisfy the view entertained by some geologists, that they have had an organic source. Hence it is probable that they (the hydrocarbons) are like effects to be ascribed to different causes. Moreover, to say that, inasmuch as we observe a certain deposit to be forming to-day by a certain process, "it is therefore a legitimate theory that all similar deposits have the same origin,"[2] is unsafe reasoning. Because limestone is now in the making as an organic deposit, *all* limestone has not necessarily been so derived. Multiplicity of causes, then, must be taken into consideration by the theorist.

On the other hand, while the cause may be single, the conditions under which it acts may be so various that the effects are manifold. If the circumstances of origin are widely different, interpretation of the results is not so difficult as it is when these conditions are hard to discriminate. Thus, a theory of wind-worn sand should have regard for the composition of the sand; the size, weight, specific gravity, hardness and cleavage of the grains; and the prevailing wind velocity. So, too, any exposition of the origin of phenocrysts in igneous rocks should be developed with due heed for variations in the acidity and basicity of magma and of country rock. Consequently, multiplicity of conditions is also to be allowed for in elaborating a theory.

[1] W. O. Crosby, "Origin of Eskers," *Am. Geol.*, XXX., p. 2.

[2] H. L. Fairchild, "Geology under the New Hypothesis of Earth-origin," *Am. Geol.*, XXXIII., p. 107.

Thus, in the intricate system of nature, *similar* products may be the outcome of *different* causes, and *unlike* products may result from *one* cause, in each case the causes working under varied conditions. Although there are many other relations between cause, condition and effect, these two are especially emphasized here because they are most easily overlooked.

Summarizing—theory and hypothesis too often suffer from the mistake, first, of overrating the importance of some one particular cause or condition, and, second, of extending, more broadly than is legitimate, the application of this factor. These fallacies are in large part due to a failure to realize the extreme complexity of the relations between cause, condition and effect.

To avoid misunderstanding and to give a theory real value, we must assign to it definite limits, beyond which criticism should not reach. Be discreet in generalization, is good counsel.

Fred. H. Lahee
Harvard University,
January 4, 1909

THE BEHAVIOR OF A SNAKE

Several years ago, while Mr. Lester and I were sauntering along a country road near Newnan, Ga., a commotion was heard in the dry leaves along the side of the road. On quietly entering the underbush, it was noticed that the noise was caused by a struggle between a coach-whip snake (*Zamiens flagellum flagellum* Shaw) and a lizard that was unknown to me. The snake was about four feet long; the lizard less than a foot. They were not fighting; the snake was trying to make a meal of the unmanageable lizard. Frequently the lizard escaped from the snake. Then would follow a chase resulting in the recapture of the lizard. The snake invariably caught the lizard by the body. I knew that, if the snake were to capture the lizard by the tail, the lizard would break off the tail and escape. The snake, behaving as though aware of this, attracted my attention and caused me to remain and study its movements.

So intent was the snake upon mastering the lizard, that it paid no attention to me, standing there as quietly as a statue. Several times the pursued lizard and the chasing snake passed across my feet. At one time, the lizard, on escaping from the snake, darted up a tall tree. The snake followed. Here the four articulated limbs of the former gave it a decided advantage. After darting up the tree for a short distance, the lizard paused and glanced backward. As soon as the snake had approached quite near, the lizard darted ahead a short distance and then again paused and glanced backward. These reciprocal movements were repeated several times. Then, all of a sudden, the snake dropped to the ground. The lizard continued to gaze downward. About a foot from the tree upon which the lizard was resting, head downward, there stood another tree. Spirally up this trunk the snake quietly and slowly climbed, until it was a few inches above the level of the lizard. The unsuspecting lizard was scrutinizingly gazing downward. Quietly and quickly the snake extended the front portion of its body, and, with a sudden dart of the head, knocked the lizard to the ground. Before the latter had time to recover from the effect of the unexpected blow, the snake had dropped to the ground and recaptured it. The lizard was not yet conquered; but this article is concerned only with the behavior up to this point.

This behavior puzzled me for a number of years. I was reluctant to call it an exhibition of logical judgment; yet it seemed entirely too complex to be regarded as reflex action and too individualistic to be considered instinctive, in the ordinary sense. From the nature of the case, tropisms, as defined by Loeb, are out of the question. Nor could it be considered a "trial and error" response; for there is no series of errors followed by a blundering into a solution and a gradual "stamping in" of the appropriate response.

The problem that confronted this snake was how to overpower that lizard. Until the lizard climbed the tree, the follow-the-stimulus movements, which were either instincts or habits, were sufficient to cause the capture of the lizard: but, the moment the latter ascended the trunk of that tree, those movements, unmodified, were inadequate. Suddenly the behavior of the snake changed. It paused, then immediately met the situation with a response which was a special modification to suit a special circumstance; and this is what we mean by a practical judgment.

I am well aware that some will call this an anecdote and desire to throw it out of court, because it was not conducted in a laboratory, under laboratory conditions, and because we do not know the whole past history of the snake and its ancestors. Nevertheless, I am coming more and more to believe that ignoring the spontaneous behavior of animals in their natural environments hinders rather than helps the solution of the problems of animal behavior; for, it is in just these situations that the animals are apt to be resourceful. More caution is needed to interpret behavior in the open than under laboratory control; but the difficulties of the task furnish no excuse for avoiding it. I am a stanch advocate of laboratory work; but, at the same time, I feel that data derived from accurate field work are of greater value than many seem to think. Accurate observations made, by trained observers, in the field furnish us with stubborn facts that should not be ignored; they need to be interpreted in an unprejudiced manner. Laboratory work and field work should go hand in hand.

C. H. Turner

Summer High School,
St. Louis, Mo.,
April 29, 1909

QUOTATIONS

INCORPORATED BENEFACTORS

Benefactors die; universities abide. At least, that has been the case in the past. But in this age of organization, benefactors have learned to perpetuate themselves as corporations. And we now have institutions chartered by acts of congress to disburse for educational purposes the charities of millionaires. The rich philanthropist, who objectifies himself in such a benevolent corporation, of

course, names the trustees; and subsequent vacancies in the board are filled by cooptation. This is a new species of corporation; but the two or three already organized hold large funds, which are likely to be greatly augmented in the future. And there is no limit to the number of such corporations, except the limit to the number of persons who possess wealth and desire to distribute it in this fashion.

I can not but think that these corporations create a new and dangerous situation for the independent and privately endowed universities. Just in proportion as these are supported by those benevolent corporations is their center of gravity thrown outside themselves. It is no longer a case of a rich man giving his money, going his way (eventually dying), and leaving the university free to manage its own affairs. The purse strings are now controlled by an immortal power, which makes it its business to investigate and supervise, and which lays down conditions that the university must accept if it is to receive grants of money. An irresponsible, self-perpetuating board, whose business is to dispense money, necessarily tends to look at every question from the pecuniary point of view; it wants its money's worth; it demands immediate and tangible results. Will not its large powers and enormous influence in relation to the institutions dependent upon it tend to develop in it an attitude of patronage and a habit of meddling? The very ambition of such a corporation to reform educational abuses is itself a source of danger. Men are not constituted educational reformers by having millions to spend. And, indeed, an irresponsible, self-perpetuating board of this sort may become a real menace to the best interests of the higher education. In the fancied interests of capital, or religion, or of education itself, it may galvanize the intellectual life of the institution it undertakes to foster.

A board of this kind should be answerable to the public, like the regents of a state university. Or, better still, let the millionaire trust the boards of trustees of colleges and universities and give them outright the capital he intends to devote to educational purposes. I believe that in all cases this plan would be best for education and best for the public interest. I make no exception of the Carnegie Foundation for the Advancement of Teaching, to which Mr. Carnegie has given such large endowment for the pensioning of professors in the colleges, technical schools and universities of the United States and Canada. And I certainly speak with no prejudice, as I regard that endowment as the best thing any benefactor has ever done for higher education in America, and I have myself the honor of being one of the trustees. But I look with concern and anxiety on the influence of such corporations on the free and independent life of our institutions of learning and research.—President Jacob G. Schurman, of Cornell University, in an address before the National Association of State Universities.

SCIENTIFIC BOOKS

The Absorption Spectra of Solutions. By HARRY C. JONES and JOHN A. ANDERSON. Publication No. 110, Carnegie Institution, Washington, D. C. 1909.[1]

This investigation of absorption spectra represents another chapter in that study of solutions, to which Professor Jones and his coworkers have so indefatigably applied themselves. Here, as before, the guiding idea has been to obtain evidence for or against the existence of *hydrates*, or more generally, of *solvates* in solution.

To investigate a system in this way, that is, by observing the effect produced by the system upon light which has passed through it, has one decided advantage. It does not in any way disturb the state of the system. When we shall understand more thoroughly the mechanism of this absorption, such a method may become not only a very rapid, but also a very accurate and elegant means of analysis. Even in our present deep ignorance in regard to this phenomenon it can often furnish us important information, as the authors of the monograph under discussion have amply demonstrated.

[1] A somewhat abridged account of this investigation has appeared in the March and April numbers of the *American Chemical Journal* of this year (1909).

The principle which underlies the whole research is that the absorption spectrum of a solution consists simply of the superposed absorption spectra of all the molecular species present in the solution. In a solution of even a single solute there may be a large number of these molecular species, namely, ions, undissociated molecules, aggregates of the ions or of the molecules, and compounds of ions and undissociated molecules with the solvent. It is evidently no simple matter to unravel the spectrum of so complicated a system and to determine the origin of the various bands.

The method by which the authors have attempted to do this has been to keep the number of molecules of some one particular species in the path of the beam of light constant, while varying the amounts of the other species, and then observing the effect produced upon the absorption spectrum. Unfortunately, the only molecular species about which we know enough to make it possible to apply this method are the simple ions and undissociated molecules. The authors therefore only carried out experiments, keeping, first, the total amount of salt, second, the number of undissociated molecules and, third, the number of ions in the path of the beam of light constant.

Many solutions were studied under the first-named conditions, that is, keeping the total amount of salt in the path of the light constant. Only a very few of these showed no change in their absorption spectra with changing concentration. This, of course, was to have been expected from our general knowledge of solutions, for the absorption spectra would only remain unchanged when either the relative concentrations of the different absorbers did not change with the concentration, or where the absorption spectra of all the different kinds of absorbers were identical. The first alternative is perhaps never fulfilled, but the second is very probably the explanation of the constant band of nickel sulphate solutions in the ultra-violet and of the whole constant spectra of dilute neodymium and praseodymium solutions.

Nearly as many solutions were studied under the second or third of the above conditions, that is, keeping the number of undissociated molecules or of ions in the path of the light constant. If, when the number of undissociated molecules was kept constant, the absorption *decreased* with the dilution, or if, when keeping the number of ions constant, the absorption *increased* with the dilution, we should be forced to the conclusion that the change in the absorption spectrum with the dilution could not be explained as being due simply to the differing absorption spectra of the ions and the undissociated molecules, as Ostwald at first proposed. Instead, we should be obliged to assume that other absorbers than the ions or undissociated molecules must have been present and that their formation or decomposition with the changing concentration of the solution was responsible for the observed variations. Just such variations were observed in the ultra-violet bands of copper salts and of cobalt chloride, in the red bands of cobalt salts, and in the whole spectrum of ferric chloride. It follows then that in these solutions, at least, other absorbers than simply ions and undissociated molecules must be present.

Two possibilities are suggested as to the nature of these additional absorbers. They may be either *aggregates* of the undissociated solute molecules or of the solute ions, or they may be *compounds* of the solute ions or molecules with the solvent. To decide between these two possibilities the authors cite the observations of Hartley, on the change of the absorption spectrum of salt solutions with the temperature. Hartley found that a rise in temperature in general produces the same effect as an increase in concentration. This, the authors consider, is evidence against the assumption of aggregates, for they reason that a rise in temperature would tend to break up the aggregates, while increase in concentration would have just the opposite effect, and hence produce an opposite, instead of the same effect on the absorption spectrum. It is not easy to see that this argument is conclusive, for whether or not the aggregates will break up with rising temperature will depend upon the heat change incident to their formation. If

heat is absorbed in the process, then a rise in temperature would increase rather than decrease their stability.

On the other hand, the authors reason that the assumption of compounds between solute and solvent, or the assumption of solvates, is in full accord with the observations of Hartley, for not only would rise of temperature tend to dissociate the solvates—but so would increasing concentration of solute. Here again, and for the same reason, it would seem that the argument, though reasonable, is not absolutely convincing, for it is by no means certain that a rise of temperature always accompanies the formation of solvates.

Another method of attack adopted by the authors was to study the absorption spectra of solutions of salts in ether, acetone and alcohol, and in mixtures of these solvents with water. Many salts when dissolved in these non-aqueous solvents gave different absorption spectra for different salts of the same colored ion, but the spectrum of any one salt was different in different solvents. In mixtures of water with non-aqueous solvents, many salts, like neodymium chloride, for instance, showed no marked change in the spectrum when the amount of water was varied from 100 per cent. to 15 per cent. But as the amount of water was still further reduced, the spectrum was found to consist of a superposition of the spectrum of the aqueous upon that of the non-aqueous solution. Similarly, when praseodymium chloride was dissolved in mixtures of water and of ethyl or methyl alcohol the same sort of change was in general observed, except that in the alcoholic solutions there appeared an entirely new and very brilliant band in the ultra-violet, having no analog whatever in the spectrum of the aqueous solution. The conclusion is drawn that these facts and others of a similar nature are inexplicable on any other than the solvate theory of solutions—and further, that solvates of *both* undissociated molecules and of ions are formed. In the case of cobalt and copper salts, the authors conclude that a series of solvates of varying complexity are formed, while in the solutions of the rare earth which were studied there exists but a single solvate.

Finally it was observed that neodymium nitrate and neodymium chloride have very different spectra in concentrated aqueous solutions, and that on dilution, the spectrum of the chloride changes but slightly, while that of the nitrate changes considerably and becomes identical with that of the chloride. The authors explain this phenomenon as follows. The nitrate radical, consisting of twelve atoms, is very much more complicated than the chloride radical, and hence would affect the light vibrations of the neodymium atom to a much greater extent. The effect of increasing solvation would, on the one hand, be of less relative importance to the nitrate than the chloride molecule, and, on the other hand, the effect of dissociation, that is, the separation of the nitrate radical from the neodymium atom, would produce much greater changes in its absorption spectrum than the removal of the chloride or bromide ions.

It can be seen from this cursory review how promising and yet how difficult is this line of attack. With the splendid spectrophotographs furnished by this investigation as a guide, still more valuable results might be anticipated from an accurate spectrophotometric study of the same solutions. The above qualitative tests of the various theories might then be supplemented by strictly quantitative ones.

Arthur B. Lamb

The Genera of Fungi. By Frederic Edward Clements, Ph.D., Professor of Botany and Head of the Department of Botany in the University of Minnesota. Pp. iv + 227, octavo. Minneapolis, The H. W. Wilson Company. 1909. $2.00.

This long-expected key to Saccardo's "Sylloge Fungorum" has now appeared from the press, as a thinnish octavo volume, bound in plain green cloth. It is not so large as to be unhandy in the using, and yet it is large enough to secure that respect from librarians and library users that its usefulness demands. In the time that has elapsed since the publication of the mimeographed edition a couple of years ago, the author has enlarged its scope, so that now a number of things are included that were not found in the original work.

Thus while the book is still essentially a key to the Fungi in Saccardo, it covers also the Fungi in Rehm's "Discomyceten" and includes the families and genera of the lichens as treated in Engler and Prantl's "Pflanzenfamilien." This treatment of the lichens is in full accord with modern botanical ideas as given in the lecture rooms of our best botanists, and yet we imagine that many a conservative botanist will be somewhat taken aback when he finds how absolutely the line between "fungi" and "lichens" has been obliterated. Thus family 18 is *Sphaeriaceae* ("fungi"); family 19, *Verrucariaceae* ("lichens"); family 20, *Hypocreaceae* ("fungi"); family 21, *Dothidiaceae* ("fungi"); family 22, *Mycoporaceae* ("lichens"), and so on; while family 36, *Caliciaceae,* includes both "fungi" and "lichens."

The "Key to Orders and Families" (pp. 1–6) gives the plan of the book, the principal succession being *Phycomycetes, Ascomycetes, Basidiomycetes* and *Fungi Imperfecti.* The boundaries of the first of these are considerably enlarged by the inclusion of the Bacteria (five families) and the Myxobacteria (one family). In the treatment of the remaining families of *Phycomycetes* they are very properly regarded as degenerated *Chlorophyceae;* so we find brief characterizations of such algal orders as *Protococcales, Spirogyrales, Vaucheriales* and *Confervales.* We imagine that some fungologists of the old school will be distinctly shocked by this close association of fungi and algae. The inclusion of *Uredinales* (*Uredinaceae* and *Ustilaginaceae*) in the *Ascomycetes,* while very acceptable to the writer of this notice, will be frowned upon by many botanists who prefer to regard them as in some way entitled to admission to the *Basidiomycetes.* These examples may serve to show that the author of the book has succeeded in putting into it some of his ideas as to relationship, which must add much to the interest as well as the usefulness of the work, especially in the hands of advanced students.

The "Guide to the Volumes of Saccardo's Sylloge Fungorum" near the end of the book will prove very helpful to every user of the many-volumed work. Likewise the alphabetical index to the families in Saccardo's Sylloge Fungorum, and Rehm's Discomyceten will be of the highest value to the mycological student. Nor must be omit reference to the glossary of Latin and English terms which will help many a student who is rusty in his Latin to "dig out" the descriptions in Saccardo.

In his preface, the author says: "No attempt has been made to revise the genera, except where the treatment had lagged behind current practise, as is particularly true of the lichens." And again: "Questions of nomenclature have necessarily been left largely to one side, but no hesitation has been felt in making certain corrections. These have dealt mostly with mistaken or neglected transliteration, and with faulty composition." Still again, "A considerable number of sesquipedalian words have been shortened and the greater number of hybrid names have been corrected."

The last quotation which we make is one that should be read by every student of the fungi—"The mycologist must have a fair equipment of technical terms, as well as a Latin vocabulary, and the sooner these are acquired the better."

The book must at once become indispensable in every botanical library, and no doubt will be in demand by every mycologist who has access to Saccardo and Rehm. Moreover, it will not take long for the student of the fungi to find that he can identify his fungi so far as genera are concerned, by means of this handy little book.

Charles E. Bessey

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SCIENTIFIC JOURNALS AND ARTICLES

The closing (October) number of Volume 10 of the *Transactions of the American Mathematical Society* contains the following papers:

C. N. Moore: "The summability of the developments in Bessel functions, with applications."

G. D. Birkhoff: "Singular points of ordinary linear differential equations."

G. A. Miller: "Automorphisms of order two."

Dunham Jackson: "Resolution into involutory substitutions of the transformations of a non-singular bilinear form into itself."

F. W. Reed: "On singular points in the approximate development of the perturbative function."

Also notes and errata for volumes 8–10, index of the volume and indices by authors and by subjects of volumes 1–10.

THE November number (Volume 16, number 2) of the *Bulletin of the American Mathematical Society* contains: Report of the summer meeting of the society, by F. N. Cole; "The groups which may be generated by two operators s_1, s_2 satisfying the equation $(s_1s_2)^\alpha = (s_2s_1)^\beta$, α and β being relatively prime," by G. A. Miller; "A note on imaginary intersections," by E. W. Davis; "Maurolycus the first discoverer of the principle of mathematical induction," by G. Vacca; "Darwin's scientific papers," by E. W. Brown; "Shorter notices": Burkhardt's Elemente der Differential- und Integralrechnungen, by L. W. Dowling; Von Dantscher's Weierstrassche Theorie der irrationalen Zahlen, by G. A. Miller; Andrews's Magic squares and cubes, by G. A. Miller; d'Adhémar's Exercices et Leçons d'analyse, by Maxime Bôcher; Heger's Analytische Geometrie auf der Kugel, by L. W. Dowling; Borel-Staeckel's Elemente der Mathematik, by Florian Cajori; Love's Mathematical theory of elasticity, by F. R. Sharpe; Manville's Découvertes modernes en Physique, by E. B. Wilson; "Notes"; "New publications."

DELETERIOUS INGREDIENTS OF FOOD [1]

THE Food and Drugs Act, June 30, 1906, states that an article shall be deemed to be adulterated, in the case of food, if it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health. The term food includes "all articles used for food, drink, confectionery or condiment by man or animals, whether simple, mixed or compound." The act does not expressly prescribe what added substances shall be deemed to be poisonous or deleterious, nor does it indicate by what properties they are to be recognized.

At first thought this omission may seem trivial, and specific provision needless, in view of the common knowledge of these matters. More mature consideration, however, leads one to realize that there is no strict definition by which noxious and innocuous substances are differentiated; and accordingly that the recognition of poisonous and deleterious substances is not altogether a simple matter. The situation is relieved somewhat by the fact that the provision applies to added ingredients not foods and not to food itself.

Under the law, then, the question of poisonous or deleterious properties of anything coming within what the law defines as a food need not be considered. Nevertheless, in arriving at standards of the deleterious properties of added ingredients not foods themselves, it is important to consider such properties of foods, since, manifestly, it is not the intent of the law to establish different standards of quality of added ingredients than is possessed by food itself. This is clearly indicated by the statement of the law that food containing deleterious ingredients is to be deemed adulterated because the added ingredient is of such poisonous or deleterious quality as may, by its presence, render the food injurious to health. Hence, if the added ingredient is only capable of becoming deleterious in the sense that food itself is, its addition to food will not render such food injurious to health in the meaning and intent of the law. To illustrate, the addition of spices to food is admitted under the law, because they are foods in the condimental sense. Nevertheless, they are capable of being distinctly deleterious if ingested too liberally, or, in some conditions of disease, if ingested in even the ordinary quantity; that is, their proper use is without deleterious effect, yet they may become injurious by abuse. In the same way, if an added ingredient is not essentially poisonous, but merely capable of becoming deleterious by abuse, it is not a poisonous or deleterious substance in the meaning and intent of the law.

It must not be supposed that this interpretation admits of the addition to food of essen-

[1] Read before the Section of Biology, New York Academy of Sciences, May 10, 1909.

tially injurious substances in quantities not injurious, since the language of the law in the use of the word "may" specifically and very properly provides against such additions. The law reads: "If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health." It is not whether the quantity does render the food deleterious, but whether the added substance is possessed of a deleterious action which is "the nature, the property, the quality, the effect" of such added substance. If it is, the substance is essentially injurious and its addition to food is adulteration; while, on the contrary, if such added substance is only capable of becoming deleterious in the sense that food itself may, then, clearly, it is not the intent and meaning of the law to regard such added substance as essentially deleterious or its addition to food adulteration because of any such deleterious possibility.

First, then, it is important to appreciate clearly the sense in which food itself may be deleterious. Considering food that is not adulterated and is suitably prepared for ingestion, a normal individual may ingest in a normal manner a certain quantity without injurious or deleterious effect. If the quantity is increased an amount will finally be reached which is in excess of the needs of the body. However, the body is capable of adapting itself for a time to the ingestion of some excess by certain physiological adaptations, such as by the storage of caloric foods, by the rapid elimination of water or by the tonic control of reactions to stimulating foods; but when the quantity is increased beyond the capacity of such adaptations the food becomes injurious to health and a train of symptoms referable to poisonous or deleterious action is produced. This is true notwithstanding the healthfulness of the food in proper amount. This injurious effect is, then, not an essential quality of the food in question, but a quality dependent upon the ingestion of an excessive quantity of the otherwise healthful food, that is, a quality dependent upon the quantitative relation. Every food is deleterious if the quantitative relation be disregarded; it is healthful only within the limts of physiological adaptation to the quantity ingested. When these limits are exceeded it becomes injurious. Such deleterious action, however, is not an essential quality of food, since in lesser amounts, as a rule widely separated from the quantity capable of producing injury, the food does not have such deleterious action; it is a property dependent solely on the quantitative relation.

In contrast to a food let us consider the action of an admittedly poisonous substance, such, for example, as strychnine. It is poisonous because it increases the irritability of motor neurons, so that even a small quantity increases greatly the impulse resulting from a given stimulus. Such an action is not advantageous to the normal body; it is deleterious, a poisonous action. If, now, the quantity of strychnine be diminished till it no longer increases the irritability of motor neurons, no action advantageous to the healthful body remains. The poisonous action in question is one of degree, being greater with large amounts and less with small but always exhibited, so long as the quantity of strychnine is sufficient to produce any effect. It is an essential quality of the strychnine and not one dependent upon the quantitative relation. So long as the strychnine produces any effect at all it exercises the kind of action which makes it a poison. The essential quality of strychnine is, therefore, that of a poison. It is a quality exhibited in all quantities of strychnine capable of producing any definite action. To be sure, there is a range of physiological adaptation on the part of the body to an attenuated toxic effect within which no injurious action is manifest; the quality of the action persists, however, even in the diminished amount. The quality which in amount is deleterious is essential to strychnine and persists so long as the quantity of strychnine suffices to produce any definite action.

In these examples we arrive at conclusions that are of general application. An essential quality is one that is exhibited by small amounts of a substance capable of producing any definite effect. When a given quality of

action is not exhibited by a quantity of substance capable of some other different action, but is exhibited only when the quantity of the substance is a certain greatly increased amount, then the quality is not an essential quality, but one dependent on the quantitative relation.

In the application of these conclusions it is advantageous to recognize the different kinds of "added ingredients." Only those that serve some legitimate purpose in the food need be considered, as other additions would obviously be sophistication; moreover, it is convenient to classify such added substance according to the particular purpose that they serve. Thus, colors and preservatives are classes of added ingredients; they are not foods and yet may serve obvious purposes. In sufficient quantity any of these substances, like food itself, may be deleterious. Whether they are essentially injurious or whether such action is dependent on the quantitative relation is, from what precedes, to be determined according to whether they may be injurious in such quantities as are useful. If in these quantities they may be injurious or if such quantities are not widely separated from the amount that becomes injurious from the quantitative relation, then safety requires that they be considered as essentially deleterious and that they come under the designation of "added poisonous or other added deleterious ingredient." If the reverse is true, that is, if in the quantities added to food for a useful purpose the substances in question do not render such article of food injurious to health but are only capable of doing so when added in quantity widely separated from the amount made use of, then such possible deleterious action is not an essential quality of the substance, but a quality dependent on the quantitative relation, and the added ingredient is not an essentially deleterious substance and does not and may not render the article of food injurious to health according to the meaning and intent of the law. This is true whether or not the substance is capable of a deleterious action by its abuse in being used in the increased amount widely separated from the quantity which subserves the purpose of its use. In this discussion, no new position is taken in regard to these matters; there is merely an attempt to present clearly distinctions which have long been established in practical life. As an example of such practise, consider the use of cream of tartar. As a result of its use rochelle salt becomes an added ingredient to the food. When ingested in relatively large quantity this substance acts as a saline purgative, abstracting fluid from the blood and in such quantity is, in health, a deleterious substance. However, such action is not exhibited in any degree by the very much smaller quantities present because of its use in food. Hence, rochelle salt because of its laxative effect in quantity is not an added poisonous or deleterious substance according to the meaning and intent of the law, notwithstanding that it may become deleterious by its abuse. Its addition to food is justified by its usefulness and by the fact that it is not essentially injurious, even though it may become injurious in the quantitative relation.

To summarize, we conclude that substances added to food are essentially injurious when incapable of serving a useful purpose in amount widely separated from the quantity that may produce deleterious effects; and that they are not essentially injurious when capable of serving a useful purpose in amount widely separated from the quantity that may produce deleterious effect, even though, in this latter instance, they may become deleterious by abuse of the quantitative relation.

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SPECIAL ARTICLES

A NEW FORM OF LIGHT FILTER FOR USE IN EXAMINING FLAME COLORATIONS

THIN transparent sheets of celluloid stained so as to give deep absorption spectra, like solutions of methyl violet and aniline blue, absorb the orange and yellow of the spectrum. The blue screen absorbs strongly from about 23 (in the spectrum scale having D at 50) to 60, that is, including the orange-red, the orange

and half the yellow. The violet screen absorbs strongly from about 33 to 70, that is, the orange and the yellow. The sodium line at 50 is therefore absorbed by both screens. Thus in the presence of sodium the red, green and blue colors imparted to the Bunsen flame by certain elements and compounds may be readily detected by means of the screens. Certain colors transmitted by one screen are absorbed by the screens together.

The strontium and the lithium flames appear deep red through the violet screen but give no color through the blue screen. Barium and boron give a vivid green through the blue screen, and only a faint green through the violet screen. Volatile calcium salts impart a strong greenish-yellow color to the flame as seen through the blue screen, but through the violet screen the color appears a pale red. Through the combined screens the flame has a tinge of green. The color flashes out only at the moment when the salt is becoming incandescent. Potassium gives through the blue screen an intense blue-violet color; through the violet screen the outside of Bunsen flame is violet and the inside violet-red; through both screens the flame appears as through the violet screen, but less bright, and with red predominating. These colors are very characteristic. The copper chloride flame appears bright blue fringed with green through the violet screen, brilliant green through the blue screen, and a paler green through both screens. The flame color of phosphoric acid is green through the blue screen, light rose color (violet-red) through the violet screen and pale green through both screens.

In getting these flame reactions from nonvolatile compounds it is, of course, necessary to use some flux or acid that will produce a volatile compound of the element sought. A silicate containing potassium may be powdered, and decomposed in a sodium carbonate bead on a platinum wire. The resulting potassium carbonate is volatile. The phosphate minerals apatite, lazulite and wavellite give the phosphoric acid reaction readily if powdered, taken up on a moistened loop of platinum wire, heated and then treated with concentrated sulphuric acid and again heated. The reaction is transient.

A screen 3×5 inches consisting of three colored strips, one blue, one violet and one blue over violet, suitable for general laboratory use, has been made for the writer by Mr. G. M. Flint, Cambridge, Mass., price 20 cents.

Such a screen is conveniently handled and is so delicate a means of identifying the elements usually sought by means of the spectroscope that its use greatly facilitates the work of laboratory instruction in qualitative analysis and mineralogy.

In case lithium light free from sodium light is wanted for use in optical mineralogy the violet screen is a very serviceable filter.

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Mineralogical Laboratory,
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August, 1909

THE SCOMBROID FISHES

In a recent paper "On the Anatomy and Classification of the Scombroid Fishes"[1] C. Tate Regan proposes to remove the family Carangidæ (with other families of more or less possible scombroid affinities) from its time-honored position among the scombroid fishes, and place it among the percoids.

This comes somewhat as a shock to many ichthyologists, who, while having doubts as to many of the so-called scombroids, have believed the family Carangidæ to be unquestionably a scombroid family. Mr. Regan writes of the family Carangidæ as follows:

> The more generalized members of this family (*Seriola*, *Naucrates*) have the anatomical characters of the Serranidæ, there being nothing in the structure of the cranium, vertebral column or pectoral arch to differentiate them from the latter, whilst genera like *Scombrops* and *Pomatomus* (*Temnodon*) connect the two families. In the Carangidæ the caudal peduncle is more slender, the caudal fin more widely forked, and the hypural embraced to a greater extent by the bases of the caudal finrays than in the Serranidæ, but the close relationship of the two families is evident.

[1] *Ann. and Mag. Nat. Hist.*, Ser. 8, Vol. III., January, 1909.

In the evident close relationship of the family Carangidæ to the percoid fishes the present writer wholly agrees. In working over the osteology of the scombroid fishes, he has found no character as yet by which these can be sharply and entirely separated from the percoid fishes.

This, however, is nothing new. It is well known that the carangoids merge more or less completely with the percoids, and so involve the rest of the scombroids. But it does not appear from Mr. Regan's paper why the other scombroids should not follow the family Carangidæ into the group of percoid fishes. His definition of the scombroids does not show characters to exclude the family Carangidæ. The following is his diagnosis of the suborder Scomberoidei as it stands with the carangoids left out:

> Air-bladder without open duct. Maxillaries more or less attached to non-protractile premaxillaries, which are typically produced and pointed anteriorly. Cranium with the orbito-rostral portion elongate and the postorbital portion abbreviate; parietals separated by the supraoccipital; no orbitosphenoid; basisphenoid present; prooties giving rise to an osseous roof to the myodome. Vertebral column of solid centra which are coossified with the arches. Pectoral arch attached to the cranium by a forked posttemporal; no mesocoracoid; pterygials more or less regularly hourglass-shaped, 4 in number, 3 of them attached to the scapula. Pelvic fins with a spine and 5 soft rays, or variously reduced, thoracic or subthoracic in position, the pelvic bones attached to the clavicles.

These characters with a few minor exceptions are characters of the percoid fishes and spiny-rayed fishes in general, including the carangoids. These exceptions are:

> Maxillaries more or less attached to non-protractile premaxillaries, which are typically produced and pointed anteriorly. Cranium with the orbito-rostral portion elongate and the postorbital portion abbreviate.

Oligoplites (family Carangidæ) has non-protractile premaxillaries, which are about as much produced and nearly as pointed as in the genus *Scomber*. Regan himself (in a footnote) finds an exception to the pointed premaxillaries in *Luvarus* (a scombroid). The character of the abbreviated postorbital portion of the cranium has many exceptions. The following are examples that are readily at hand; many more and perhaps better ones might be found. Of the family Scombridæ *Auxis, Rastrelliger* and *Scomberomorus* have the postorbital portion of the cranium scarcely abbreviate or the orbito-rostral portion elongate. Furthermore, the following carangoid and percoid fishes have these portions as much abbreviate and elongate, if not more so: *Trachurops, Gnathanodon* and *Selene* of the family Carangidæ, and *Aphareus, Orthopristis* and *Priacanthus* of different percoid families.

On the other hand, the more generalized members of the family Carangidæ have as many anatomical characters of the scombroids as of the percoids, and the well-known characters which have always appeared in connection with them (here repeated) possess enough weight to prove a closer affinity to the former than to the latter group. Scales small and cycloid; preopercle entire in the adult; caudal peduncle very slender; the caudal fin widely forked; a caudal keel and finlets sometimes present and "the hypural embraced to a greater extent by the bases of the caudal fin-rays than in the Serranidæ" (as Regan points out). Their general appearance, which should not be entirely ignored, is in favor of a closer relationship to the scombroids.

And so it appears that if the scombroids and percoids are kept apart the family Carangidæ will have to remain a member of the former group. The alternative is to consider them as one group.

The typical representatives of the scombroids and percoids are very different and they have been considered apart because they apparently form such natural groups; the scombroids centering about the family Scombridæ, and the percoids about the family Serranidæ. But the important characters that might separate them all have exceptions, and the other characters are insignificant.

Jordan and Evermann in "Fishes of North and Middle America"[2] arrange the scombroids

[2] *Bull. U. S. Nat. Mus.*, No. 47.

and percoids with the berycoids and other less important groups together under one suborder. This suborder is subdivided into "groups" so called doubtless to express a separation of convenience rather than of exactness. The following two paragraphs appear respectively under the groups Scombroidei and Percoidea.

Scombroidei.—This group of mackerel-like fishes is not capable of exact definition, its deviations from the ordinary type of spiny-rayed fishes being various and in various directions, so that no set of diagnostic characters will cover them. The group is not a suborder as the term is generally understood; it is incapable of simple definition, and in its divergence some members approach to other groups more nearly than to extreme or even to typical members of their own. The group is, however, a somewhat natural one, as by the common consent of ichthyologists its different types have always been kept near each other in the system of classification.

Percoidea.—A group of fishes of diverse habits and forms, but on the whole, representing better than any other the typical acanthopterygian fish. The group is incapable of concise definition, or, in general, of any definition at all; still, most of its members are definitely related to each other, and bear in one way or another a resemblance to the typical form, the perch, or more strictly, the sea bass of Serranidæ.

Dr. Jordan in his "Guide to the Study of Fishes" (Henry Holt & Co., New York, 1905) places the percoids and scombroids together in a suborder, excluding the other groups before associated with them, but still considering them under separate group names. This seems to be for the present the most rational treatment of the subject.

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LUMINOUS TERMITE HILLS

Many years ago, while in the Amazon region, I found that the termite hills, which are there such a conspicuous feature in many localities, are luminous at night. My first acquaintance with this phenomenon was made in the vicinity of Santarem, Brazil, upon a nocturnal walk through the forest. In the company of some natives I was following one of the narrow paths which lead to the scattered habitations. The darkness beneath the canopy of foliage was absolute and progress was only possible by the "feel" of the ground under foot. Suddenly there appeared through the foliage a luminous area composed of innumerable points of phosphorescent light which appeared to shift and fuse into each other, thus forming more brilliant patches which were constantly resolving themselves and again appearing. This light suggested the steady diffused glow of the familiar "fox fire" rather than the more brilliant display of the fire-flies, yet the slow and confused movements which seemed to pervade the whole luminous zone were strongly suggestive of insects. Upon my expression of surprise the natives replied laconically, "cupim," the native name for termite.

The luminous area was indeed one of the large termite hills which are scattered through those parts of the forest not subject to inundation. These termite hills rise from the ground in an irregular conical mass to a height of from five or six feet to perhaps ten or twelve. They are constructed of clay and are exceedingly hard. The mounds are perfectly bare of vegetation and on that account have a characteristic appearance of newness. Afterwards I frequently saw these luminous termite hills and they added in no small degree to the mystery and charm of the tropical nights. I remember one display of particular splendor , seen when visiting at a house which commanded a view over a large clearing. Numbers of termite hills were scattered over the clearing, and at night, when these all glowed and scintillated upon the black forest background, the spectacle was one never to be forgotten.

Unfortunately I took it for granted that such a conspicuous phenomenon must be well known to naturalists and so did not investigate it. Since then I have searched the available literature on termites and on luminous insects and have questioned entomologists and botanists in the vain hope of obtaining information on this subject. The phenomenon appears to have remained unknown to naturalists. The only references to it that I

have been able to find are a brief mention in Herbert H. Smith's "Brazil, the Amazons and the Coast," p. 139 (1879), and my own allusion to it in *Entomological News,* Vol. 6, p. 15 (1895). Are the termites themselves luminous or is the phosphorescence due to some fungoid peculiar to the termite hills? Certain it is that the mounds are all phosphorescent. Smith says: "The phosphorescence is in the hills themselves, not, so far as I know, in the insects"; yet, he does not appear to have investigated this question and his statement is merely an opinion. The fact that no luminous neuropteroid insects are known argues against the theory that it is the termites themselves that emit the light, yet observations on nocturnal insects in the tropics, particularly forest insects, are so rare that such a property might easily have escaped notice. Should the light be caused by a fungus it must be one that is peculiar to the termite mounds. In the latter case, however, one would suppose that when, by the clearing of the land, the nests are exposed to the direct rays of the tropical sun the fungus would be killed; but the mounds continue luminous even in the older clearings where they have been exposed to the sun for years.

During my visit to Central America in 1905 I looked for termite nests in the hope of obtaining some data on this subject. However, I saw no termite hills like those so common in the Amazonian forests. The nests of *Eutermes,* the common form in Central America, which are built on trees and constructed of woody particles, gave entirely negative results. On one occasion I broke open one of these nests at nightfall to see if the termites within were luminous, but they showed no trace of phosphorescence.

FREDERICK KNAB

THE PLANT REMAINS OF POMPEII

BEGINNING with the destruction of Krakatoa in August, 1883, within the past twenty-five years, a new era of catastrophism may be said to have begun. The events of 1902 are still fresh in the minds of most people; the destruction by earthquake on January 16 and April 18, respectively, of the towns of Chilpancingo in Mexico and Quetzaltenango in Guatemala; the eruption on May 8 of Pelée with the annihilation of St. Pierre. The partial destruction of San Francisco in April, 1906, due to a fault in the earth's surface along the Pacific coast of America, and the reawakenment of Vesuvius with the burial of Ottajano, at the foot of the volcano, are all too recent catastrophes. These manifestations of nature's force were followed by the destruction of Valparaiso in August, 1906, and Kingston, Jamaica, in January, 1907. The most recent event in which we see earth in the making, occurred at the southern end of Italy on December 28, 1908, when by an earthquake and tidal wave, the cities of Messina, Catania and Reggio were shaken from their foundations. The events of this horror are too recent to need comment, but in view of the wide-spread interest in seismic phenomena, the writer recalls a visit to Pompeii in the summer of 1907, followed later by a visit to the National Museum in the city of Naples, where the art objects and objects of commercial and domestic use are carefully preserved from the destructive action of ash storms, wind and water. A study of the ruins of Pompeii, which was destroyed by ashes, much as Ottajano was destroyed three years ago, gives one the background to picture the civilization of the ancient Pompeiians, while a study of the objects classified in the National Museum enable the student to reconstruct the daily life and industries of that pleasure-loving people. Always interested in such matters in a general way, the writer endeavored to find what materials in such a museum bore upon the study of plants. With this in view, the museum was searched and a small collection of the plant remains of the buried city was found in one corner, and the labels in modern Italian attached to the specimens were copied, making a list of twenty plants or plant parts, that could be identified certainly in the fragmentary condition in which they were preserved in the dwelling houses beneath the layers of ashes and pumice stone vomited forth by the volcano. The list

of names and their identification are given below in the hope that the list may be made permanently useful.

Agli = the garlic.
Avellani = the filbert.
Castagne = the chestnut.
Cipolli = the onion.
Coriandrum sativum = the coriander.
Fave = the bean.
Fave a meta = bean remains in fecal matter.
Fichi e uva pressa = figs and pressed grapes.
Fichi secchie a coppie = dried figs in pairs.
Fiori di melo grande = flowers of large apples.
Frammenta di pigna = fragments of pine cone, seeds included.
Garubbe = the carob.
Grano o orzo mondato = grain freed of its hull, or covering.
Hordeum hexastichum = 6-rowed barley.
Hordeum tetrastichum = 4-rowed barley.
Lenticchi = the lentil, the pulse.
Mandorle = the almond.
Miglio = the millet.
Noci = the walnut.
Pere = the pear.

We see by an inspection of this list that the residents of Pompeii used as vegetables the onion, the garlic, the bean and the lentil, while the barley (of two kinds), the millet and the chestnut were probably ground to make bread. The fresh fruits of the table were the grape, the fig, the apple and the pear. As edible nuts, the Pompeiians used filberts, chestnuts, pine seeds, walnuts and almonds, while the dried fruit comprised the fig, the carob and the grape. This is evidently only a partial list of plants actually used in Pompeii, for, as in all large cities, the vegetables and fruits sold in the markets vary with the season and the above list represents the plants on sale during late August, the date of the destruction being August 24, 79.

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NOTES ON A NEMATODE IN WHEAT

During the season of 1909, a nematode in wheat has made its appearance in different parts of the United States. It was found by members of the Office of Grain Investigations at Modesto, Cal., May 28, 1909, and authentic reports of its presence have since been received from Georgia, West Virginia and New York.

Affected wheat heads are similar in appearance to "bunted" heads. The glumes of the spikelets spread somewhat and galls, dark in color and full of nematode larvæ, occupy the places where the kernels should be. The nematode is undoubtedly *Tylenchus tritici* Roffr., and has been known in Europe since 1745. Its life history is described by Davaine in *Comptes Rendus Acad. Sc. Paris,* Part 41, 1855, pp. 435–438 and Part 43, 1856, pp. 148–152. The European literature on the subject is extensive, but no American citations of its occurrence in the United States are known to the writer. Sorauer in his "Handbuch der Pflanzenkrankheiten," Teil III., gives a good account of the parasite and mentions it as occurring in Sweden, Holland, Germany, Austria-Hungary, Switzerland, Italy, North America and Australia (?). Dr. E. A. Bessey in a letter of June 19, 1909, says that he has observed related forms on species of *Agropyron, Elymus, Calamagrostis, Trisetum, Chætochloa, Agrostis* and *Sporobolus* from various parts of the United States, but has not observed any form attacking wheat. The parasite has already gained headway in fields around Old Field, W. Va., and may prove a serious pest.

Infested wheat should be cleaned thoroughly before sowing. Dr. N. A. Cobb recommends cleaning by winnowing, sieving or skimming off the floating galls after the seed-grain has been submerged in water. Dr. E. A. Bessey suggests the probable efficiency of hot-water treatments such as are used for smut, and also mentions a treatment consisting of steeping seed in a two to five per cent. sulphuric-acid solution for one half to two hours. Sorauer, *l. c.,* recommends soaking infested seed in dilute sulphuric acid (1 kg. sulphuric acid to 150 l. water) for twenty-four hours. Further experiments are necessary before acid and hot-water treatments can be safely recommended.

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